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Corn (Maize) Viruses in the Continental United States and Canada

Agricultural Research Service
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Underscored numbers in parentheses indicate references in the literature citations placed at the end of each section.

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CORN (MAIZE) VIRUSES IN THE CONTINENTAL UNITED STATES AND CANADA

INTRODUCTION

Warren N. Stoner[1]

Prior to 1962 virus diseases of corn, Zea mays L., were not considered a significant factor in corn production in the continental United States and Canada, but several viruses had been found infecting corn in the field and were characterized and named. In some instances, these viruses had caused sporadic localized losses in relatively small plantings in Southern and Western States, but the principal corn-producing areas, particularly the so-called Corn Belt of the north-central region of the United States and the Ontario Peninsula of Canada, were believed relatively free of viral pathogens of corn.[2]

In 1961 there were reports of an abnormality of corn occurring in small restricted areas near Alexandria, La., and Yazoo City, Miss. The same abnormality recurred in the same general areas but over much greater acreage in 1962, with losses serious enough to adversely affect corn production in Yazoo County, Miss.

Recurrence of the condition in greater severity in 1963 involving previously undetected areas of infection and considerably more acreage caused grave concern. A. J. Ullstrup[3] and the author, in company with personnel from State College, Miss., made field observations and preliminary surveys in Mississippi in July and August of 1963. These observations indicated the condition could not be ascribed to corn pathogens usually found in the area, insect injury, soil conditions (including trace element deficiencies or toxicities), or cultural practices. The symptoms observed in the affected plants were very similar to those caused by corn stunt disease, and the condition was tentatively ascribed to infections of corn stunt virus.

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[2] In 1964, D. W. Creelman, Editor, Canadian Plant Disease Survey, reported: "Our records of the Canadian Plant Disease Survey which go back to 1921 do not record the incidence of corn stunt on either field corn or sweet corn in this country since that time. The only virus disease recorded on corn is one occurrence of ring spot in southern Ontario." Personal communication.

[3] Plant Pathologist, Crops Research Division, ARS, USDA, and Professor of Plant Pathology, Purdue University, Lafayette, Ind. 47907.

In August of 1963, Ullstrup and Stoner, in company with personnel of the Ohio Agricultural Research Center, observed the same general type of symptoms causing economic losses in the bottomlands at the confluence of the Ohio and Scioto Rivers near Portsmouth, Ohio. The symptoms and field conditions observed in Ohio closely resembled those seen in Mississippi and it was again believed the trouble was being caused by corn stunt virus, but the presence of this virus was not confirmed.

In October of 1963, Maramorosch (28) reported transmission of corn stunt virus from corn plants collected in the fields in Mississippi.

In November of 1963, a meeting of investigators and administrators interested in the problem was held at State College, Miss. Informal reports from those present indicated that other States perhaps had the same or a similar condition in corn. Many investigators present were interested in organizing some type of cooperative effort to define and delimit the problem and in developing a means of centralizing and circulating information. The discussions also indicated a need to prepare and publish (1) a leaflet on corn stunt for general use, (2) a résumé of corn stunt virus, and (3) a summary of the 1963 observations. It was decided that those present could serve as a nucleus for an informal cooperating group. These, with others contacted by letter, were the ones that began and continued cooperative investigations.

It should be noted that L. H. Williams of the Ohio Agricultural Research and Development Center, Wooster, Ohio, reported at this meeting the mechanical transmission of a nonpersistent virus from corn. In the above-mentioned report, Williams clearly indicated that a virus distinct from corn stunt virus was infecting corn in the field in Ohio.

Several workers reported virus diseases of corn in their respective States late in 1963 (18, 22, 24, 28), and an information sheet on corn stunt was prepared and published in cooperation with the Mississippi Agricultural Experiment Station in April 1964 (40).

Williams and others (48), working through the winter of 1963 and spring of 1964, were able to show that the nonpersistent virus occurring in Ohio was different from known corn viruses in the United States, with the possible exception of sugarcane mosaic virus. Various investigators continued to report on different aspects of the corn virus problem over the United States through 1964 (5, 11, 23, 34, 37, 46), and an annual summary on corn virus information through 1963 was published in August 1964 (36).

On September 18, 1964, Hepner and Douglas (15) reported the first known occurrence of *Dalbulus maidis* (DeLong and Wolcott) in Mississippi and Louisiana. This leafhopper is one of the two then known vectors of corn stunt virus.

In November 1964, more than 100 scientists from Canada and the United States attended a corn virus conference sponsored jointly by the Ohio Agricultural Research and Development Center and the U.S. Department of Agriculture at Wooster, Ohio. Investigators representing many disciplines presented reports of the 1964 studies and surveys. After they had discussed and carefully considered the presentations, the conferees agreed on broad points of the problem.

First, a complex of at least three viruses -- corn stunt virus (CSV), sugarcane mosaic virus (SCMV), and a third nonpersistent type virus (possibly related to SCMV) -- seemed involved. This third virus, first found by Williams and coworkers (46, 49), had been at least partially characterized and was known to be, at least experimentally, transmitted by an aphid vector (42). The conferees agreed to call this virus "Maize Dwarf Mosaic Virus (MDMV)" and the disease it caused "Maize Dwarf Mosaic (MDM)."

Williams also reported at this conference transmission by mechanical inoculation of what appeared to be yet another nonpersistent virus from corn in Ohio that was distinct from MDMV. He called this virus 3A virus, deriving this from the number of an inoculation series. The virus was recovered from corn kernels showing a red-striping symptom. Such red-striped grains seemed to be most prevalent in the northeastern part of Ohio. Other investigators at the conference indicated that a similar red striping of corn kernels had been observed in southern Michigan and northeastern Indiana. It was not known, however, if the red-striping symptom of the kernels was a manifestation of virus infection, but there was at least an association of the symptom in the corn kernels that had been used as sources in the initial transmission of the 3A virus. Limited host range studies had shown the 3A virus also infected wheat, producing symptoms similar to those induced by wheat streak mosaic virus in wheat seedlings.

A second point of broad agreement was that the areas of occurrence of these viruses were not clearly defined and, in fact, might possibly overlap considerably. Evidence available then indicated that MDMV occurred predominantly in the northern corn-producing areas, CSV in the Southern and Southwestern States, and SCMV infections in corn were distributed primarily in California and in areas where sugarcane is grown.

The experiences of the cooperators in the 1964 surveys and the reactions of test plants used in relatively limited inoculation studies indicated that symptoms in corn alone, either in the field or greenhouse, would not suffice to separate MDMV, CSV, and SCMV. It was agreed that a greater number of tests and more critical techniques would have to be used to identify the viruses and thus determine their areas of occurrence.

Observations of many commercial fields and preliminary plot tests of many corn lines and varieties in several States indicated strongly that there was germ plasm either "tolerant" or "resistant" to MDMV. It was agreed that more extensive trials were needed, and more formalized plans were made for further resistance test plots.

It was also now apparent that these viruses had definitely caused increasing economic losses for at least 3 successive years in many areas and that the areas involved were either increasing in number and extent or becoming better delimited through the surveys. The losses seemed to vary from season to season in both severity and extent in many areas, but it seemed reasonable to believe they would probably be recurrent.

A seemingly different virus of corn was reported from Iowa at this meeting. This virus had been recovered from corn and other gramineous hosts, *and also from two broadleaved plants*, groundcherry (*Physalis* sp.), and soybean (*Glycine max* (L.) Merr.) (27).

It was agreed to continue both the cooperative investigations and the individual studies then being developed in 1965. Particular emphasis was given to continuing the surveys, and field identifications were to be confirmed whenever possible with virus transmission trials. The search for alternate hosts of the viruses and suspected vectors was to continue. Test plots for assaying corns for resistance to MDM were to be more extensive.

Individual investigators continued to publish their findings in the spring of 1965 (4, 6, 12, 19, 21, 25, 26, 29, 44).

A résumé of corn stunt was completed (38), and the 1964 summary of cooperative investigations was published in the fall of 1965 (39).

A regional project was prepared and submitted for approval in the spring of 1965. This project was activated, as project NC-79, "Dwarfing Virus Diseases of Corn," on July 1, 1965. Fourteen States were represented in this project, and eight of these had submitted particular projects and had them implemented for work from July 1, 1965.

Various investigations previously begun by individual workers were beginning to yield significant results, and data on various aspects of the corn virus problem continued to be published (8, 10, 17, 30, 31, 32, 47, 49).

A conference of the cooperators and others interested in corn viruses was held at Purdue University, Lafayette, Ind., in mid-November 1965. Individual investigators presented results of their findings for the year, with each presentation being followed by a general discussion. The 1965 investigations, in general, confirmed the preceeding years observations and points of agreement. New information was obtained particularly on MDMV and CSV. The virus disease of corn reported in 13 counties in Iowa in 1964 (27) was not seen in the field in 1965 and cultures of it in the greenhouse were lost.

The red-stripe symptom of the pericarp of corn was seen in the field again in 1965, and further investigations of the "3A virus" indicated that this virus could perhaps be wheat streak mosaic virus (WSMV) or a strain of it (49).

Maize dwarf mosaic was characterized in greater detail, and a possible relationship to sugarcane mosaic virus was indicated (8, 33, 47). Further reports on MDM in 1965 covered distribution of the virus, varietal susceptibility of sweet corns to the disease, and further studies of the characteristics of the virus (10, 17, 31, 32).

Publications of continuing investigations appeared in 1966 while this summary was in preparation. Many of these are pertinent to particular sections of this presentation and are included here for reference. For detailed information on the distribution of MDM, see (2, 3, 16, 20, 30, 35, 45). Several additional aphid vectors, additional host plants, physical-chemical characteristics, and serological studies of MDMV are in the 1966 literature (1, 7, 43). Evidence has been presented indicating that CSV may not occur in California (13), and a listing of leafhoppers collected from corn in the Southeastern United States (9) includes *Graminella nigrifrons* (Forbes), the black-faced leafhopper, which has been proved recently to be a vector of CSV (14). (See also the Mississippi section of this report.) A general treatment of corn virus diseases in the United States presented late in 1965 was published early in 1966 (41).

Further observation of commercial plantings and more critical studies in test plots throughout the range of corn viruses in 1965 confirmed that there is some degree of tolerance or resistance to the viruses in many commercial and experimental corn lines. Some of these data and detailed information of the test plots have already been published (17, 50). Other data of plot tests are presented in this report. In some cases investigators are currently preparing their data for publication. The volume of information on tolerance and resistance is rapidly increasing and may, with current-season results, be summarized in the near future. The references cited and the data given in the sections of this report, however, should be useful to breeders, agronomists, geneticists, and others as the most current information available. Specific questions on the plot trials in the different locations should be addressed to the authors of the cited literature or of the appropriate sections in this presentation.

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ALABAMA

DISTRIBUTION AND SOME PROPERTIES OF A SAP-TRANSMISSIBLE VIRUS ISOLATED FROM CORN IN ALABAMA[1]

Robert T. Gudauskas and Donald W. Gates[2]

ABSTRACT

Stunted and discolored corn plants were observed in 30 Alabama counties in 1965. A sap-transmissible virus was associated with the disease in only one county, and limited transmission tests for corn stunt virus were negative. Properties of the sap-transmissible virus were similar to those reported for maize dwarf mosaic virus.

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INTRODUCTION

Suspected viral diseases of corn have been frequently observed in Alabama. In 1963 a disease resembling corn stunt was found in 4 counties, and in 1964 the disorder was recorded in 18 counties with heavy losses noted in several fields. Tentative diagnoses of the disease as corn stunt were based solely on symptomatology.

The recent outbreaks of corn stunt (9, 10, 14) and maize dwarf mosaic (4, 11, 16, 17), or disorders resembling the two (1, 2, 3, 5, 6, 7, 8, 12, 13, 15), have established viral diseases as threats to corn production in the United States. Because of the increasing importance of apparently similar disorders in Alabama, we attempted to determine if viruses were associated with diseased corn in the State.

VIRUS DISTRIBUTION

Surveys of cornfields for viral diseases were conducted from mid-June to early September 1965. No attempt was made to survey the entire State or to make an exhaustive survey within counties. Fields selected for inspection were those of suspected disease occurrence as reported by farmers and personnel of the Agricultural Experiment Station and the Cooperative Extension Service of Auburn University.

Representative samples of suspect diseased corn and johnsongrass plants were collected from each field, placed in plastic bags on ice, and transported to Auburn where they were assayed for sap-transmissible virus(es). Leaf tissues of corn and johnsongrass were ground in a mortar and the resultant sap swabbed with cheesecloth pads onto abrasive-dusted leaves of seedling corn (*Zea mays* L. 'Dixie 18'), sweetcorn ('Stowell Evergreen'), and sorghum (*Sorghum vulgare* Pers. 'AKS 614').

Samples of diseased corn plants from 12 fields in 6 counties were sent to W. A. Douglas, U.S. Agricultural Research Service, State College, Miss., for transmission tests with known vectors of corn stunt virus (CSV).

Survey.--Corn plants showing symptoms suggestive of viral infections were found in 30 of the 40 counties visited in 1965 (fig. 1). These counties, with cities nearest to sampled fields indicated in parentheses, were: Autauga (Prattville), Baldwin (Fairhope), Barbour (Eufaula), Butler (Greenville), Chambers (Waverly), Cherokee (Centre), Chilton (unknown), Cleburne (Heflin), Elmore (Tallassee, Wetumpka), Escambia (Brewton), Fayette (Fayette), Franklin (Russellville), Geneva (Geneva), Greene (Mantua), Hale (Greensboro), Henry (Headland), Jefferson (Bessemer), Lamar (Millport), Lawrence (Moulton), Lee (Auburn), Limestone (Athens, Belle Mina), Macon (Notasulga), Madison

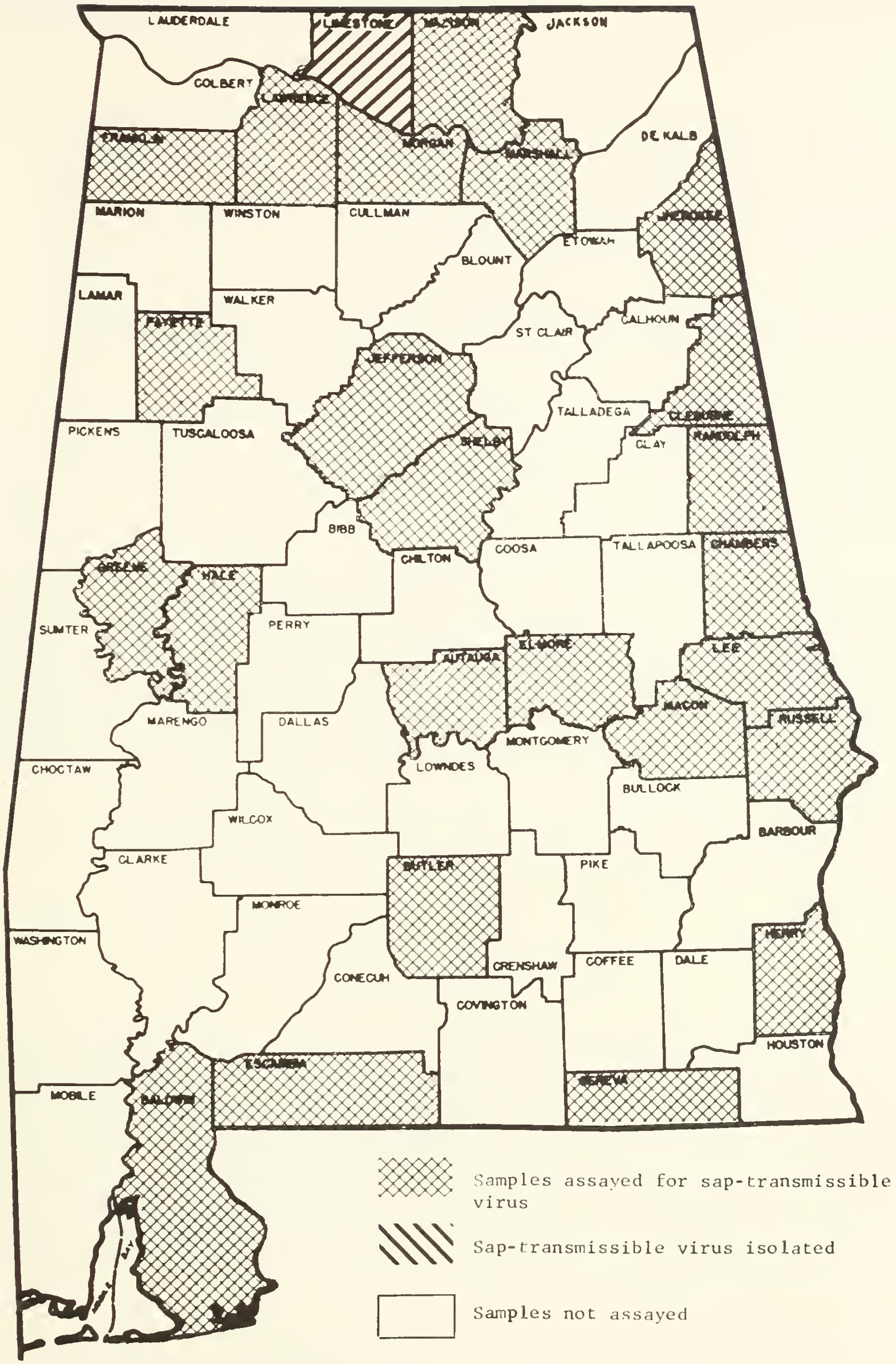

FIGURE 1.--Distribution of stunted and discolored corn in Alabama, 1965.

(Huntsville), Marion (Hamilton), Marshall (Union Grove), Morgan (Decatur), Randolph (Wedowee), Russell (Seale), Shelby (Harpersville), and Tuscaloosa (Tuscaloosa).

Diseased plants were typically stunted and showed leaf discoloration ranging from chlorotic mottle or striping to red to purple streaking, often involving entire leaf blades. Abnormal ear formation and development were also common symptoms. Overall losses appeared to be light, although yield reductions in some fields were estimated as high as 50 to 75 percent.

Sap-Transmissible Virus.--Of samples assayed from 25 counties, a sap-transmissible virus was isolated only from plants collected in Limestone County (fig. 1), but from 3 separate fields within that county. The virus was isolated from johnsongrass as well as corn collected at each of these fields. Criteria for designating the sap-transmissible agent as a virus were: (1) its infectious nature as determined by serial transfer with constant symptom induction in test plants, and (2) absence of any other recognizable infectious agent.

Symptoms on test plants (corn, sweet corn, sorghum) appeared in youngest leaves within 4 or 5 days following inoculation and were manifested as chlorotic spotting followed by eventual mottle. Corn plants artificially infected with the virus and allowed to grow in the greenhouse were only slightly stunted and failed to develop the red discoloration of leaves usually seen in the field. Such discoloration, however, did occasionally appear in inoculated sorghum plants.

Corn Stunt Virus.--Transmission tests with known vectors of CSV on field-collected corn were negative.[3]

VIRUS CHARACTERIZATION

A host range and some properties of the sap-transmissible virus were determined. Standard extract for the tests was the undiluted sap obtained by grinding virus-infected leaves of sweet corn ('Stowell Evergreen', infected 2 to 3 weeks) in a food grinder and expressing the pulp through cheesecloth. Inoculations were made with cheesecloth pads onto abrasive-dusted leaves of (1) various seedling plants in the host range study, or (2) sweet corn plants, 2- or 3-leaf stage, for physical property determinations. Property tests were repeated three times and 6 to 20 plants were used for assaying a treatment within any particular test.

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[3] Personal communication from W. A. Douglas, Oct. 22, 1965.

Physical Properties.--Virus-containing sap held at 20°C. was infective after 48 hours but not after 54 hours. When the sap was maintained at 6°, infectiousness was retained for 72 hours. The dilution end-point was between 10^{-4} and 10^{-5} in demineralized water, and the virus was inactivated in 10 minutes at 55° but not at 50°.

Host Range.--In addition to numerous varieties of *Zea mays* L., other plants found to be susceptible to infection by the virus were: *Bothriochloa* sp.; *Pennisetum glaucum* (L.) R. Br. (pearl millet) 'Starr'; *Sorghum halepense* L. (johnsongrass); *S. sudanense* (Piper) Stapf. (sudangrass), 4 cultivated varieties; *S. vulgare* Pers. (sorghum), 17 cultivated varieties; and sorghum-sudangrass hybrids, 26 cultivated varieties.

Nonsusceptible plants, as determined by lack of symptoms and failure to recover the virus from inoculated plants, were: *Bromus catharticus* Vahl. (rescuegrass); *Festuca arundinacea* Schreb. (fescue); *Lolium multiflorum* Lam. (ryegrass) 'Gulf'; *Phalaris tuberosa* var. *hirtiglumis* Batt. & Trabb. (koleagrass); *P. tuberosa* var. *stenoptera* (Hack.) Hitchc. (hardinggrass); *Triticum aestivum* L. (wheat) 'Monon'; *Capsicum frutescens* L. (pepper) 'California Wonder'; *Chenopodium amaranticolor* Coste & Reyn.; *Crotalaria spectabilis* Roth; *Cucumis sativus* L. (cucumber); *Cucurbita pepo* L. (squash) 'Early Yellow Prolific Straightneck'; *Datura stramonium* L. (jimsonweed); *Dolichos lablab* L. (hyacinth-bean); *Glycine max* (L.) Merr. (soybean) 'Harosoy #63'; *Lycopersicum esculentum* Mill. (tomato) 'Bonny Best'; *Nicotiana glutinosa* L.; *N. tabacum* L.; *Phaseolus lunatus* L. (lima bean) 'Sieva'; *P. vulgaris* L. (bean), several cultivated varieties; *Pisum sativum* L. (pea) 'Alaska Earliest of All'; *Trifolium pratense* L. (red clover) 'Kenland'; *Vicia sativa* L. (vetch); *V. narbonensis* L.; *V. serratifolia*; *Vigna sinensis* (L.) Endl. (cowpea) 'Black'; and *Zinnia elegans* Jacq. (zinnia) 'Canary Yellow, Lilliput'.

CONCLUSIONS AND DISCUSSION

Investigations conducted during the summer of 1965 revealed the widespread occurrence of a corn disorder in Alabama having symptoms similar to those described for corn stunt (14) and maize dwarf mosaic (16, 17). The cause(s) of the disease throughout the State was not established although the association of a sap-transmissible virus with diseased corn in one county was demonstrated. Characteristics of the virus were similar to those reported for maize dwarf mosaic virus (11, 16, 17) and related, if not identical, viruses recently isolated from corn in several areas of the United States (2, 3, 6, 7, 12, 13, 15).

Failure to isolate the sap-transmissible virus from corn in 24 of the 25 counties sampled might superficially suggest that corn stunt virus (CSV) was the major cause of the diseased corn observed in Alabama in 1965. Such a supposition would seem reasonable in light of the widespread occurrence of known and suspected corn stunt in neighboring States of Mississippi (14) and Georgia (8). However, CSV was not isolated from Alabama corn in the limited transmission tests with known vectors of the virus. Since many factors can influence virus transmission, the failure to isolate CSV or the sap-transmissible virus might only reflect the techniques used rather than occurrence and distribution of the viruses. Alternatively, the possibility that the principle cause of the corn disease in Alabama was an agent other than these viruses cannot be dismissed on the basis of present evidence.

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ARKANSAS

SUMMARY OF CORN VIRUS RESEARCH IN ARKANSAS

J. L. Dale[1]

What was apparently virus-infected corn was first noticed in Arkansas in one area late in 1962. In 1963 a considerable acreage of affected corn was observed in central and north-central Arkansas. In early 1964 a mechanically transmissible virus was isolated from corn collected from all but the southeastern part of the State. In addition to the mechanically transmissible virus that causes maize dwarf mosaic, there also appears to be a second but nonmechanically transmissible virus present in the southeastern part of the State.

Work done on corn viruses in Arkansas has been reported in several publications (1-7).

The distribution of maize dwarf mosaic in Arkansas has been determined by transmission studies on affected material collected from throughout the State. The causal virus has been isolated from plant material collected from the following counties: Baxter, Carroll, Conway, Crawford, Faulkner, Franklin, Grant, Hempstead, Hot Springs, Howard, Independence, Johnson, Lawrence, Little River, Marion, Mississippi, Pike, Pope, Pulaski, Randolph, St. Francis, Scott, Sharp, Stone, Van Buren, Washington, and Yell.

Work is presently being conducted on host range studies, transmission, and serology.

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CALIFORNIA

THE CORN VIRUS SITUATION IN CALIFORNIA

Quintin L. Holdeman[1]

ABSTRACT

The only virus disease of corn found in California during surveys in 1964 and 1965 was sugarcane mosaic. Two strains of the virus were encountered: sugarcane mosaic virus (SCMV) and a strain of sugarcane mosaic virus that infects johnsongrass (SCMV-Jg). SCMV-Jg was found in 14 counties causing an estimated loss on corn for 1965 of $112,570. The number of acres that would be needed to replace the losses in yield for sweet corn, grain, and silage are 400, 36, and 28 acres, respectively. SCMV-Jg overwinters in the perennial reservoir, johnsongrass. Inoculation studies indicate that other potential perennial reservoirs are *Imperata brevifolia*, *Saccharum officinarum*, *Sorghum almum*, and natural sorghum x johnsongrass hybrids. In addition to mosaic, necrotic reactions to SCMV-Jg have been observed in the field on certain varieties of corn and sorghum.

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INTRODUCTION

The reports of serious damage to corn in the Midwest due to a virus disease, coupled with the identification of a mechanically transmitted virus on corn in California, indicated a need for an evaluation of the situation. Such information would be useful as a basis for deciding the research that would be needed and also the urgency of the problem. Surveys to determine the occurrence and distribution of all corn virus diseases in California and to evaluate their present and potential damage to the corn crop were initiated in 1964 and intensified in 1965.

PREVIOUS WORK IN CALIFORNIA

The first suggestion of a virus disease of corn in California was published in 1945, when Frazier (3) described a "streak disease" he had observed in the Woodlake area of Tulare and Fresno Counties since 1942. His description of the disease (3) and notes recording symptoms on johnsongrass in 1943 (5) indicate that he was observing the same disease that was found in the same area in 1963.

In 1946 Kunkel (8) reported corn stunt virus in the Rio Grande area of Texas and the Woodlake area of California. He stated that the virus was readily transmitted by the leafhopper *Dalbulus maidis* (DeL. & Wol.). Attempts in 1947 by Frazier and Freitag and coworkers to confirm leafhopper transmission in California met with failure (4, 5). A critical study of the data presented in the 1946 publication (8), as related to California, leaves room for serious doubt as to the validity of the report of corn stunt virus in California.

Stoner (14) in 1952 reported that leaf fleck, a disease of corn collected in the bay area of Alameda and Contra Costa Counties in 1946, was due to an aphid-transmitted virus, maize leaf fleck virus.

Cucumber mosaic virus on corn was collected by Stoner (13) about 1948 in Stanislaus and Tulare Counties.

In 1963 and 1964, activity was initiated independently by research personnel at the University of California at Davis and at the University of California at Berkeley on a newly discovered (11) or rediscovered (4) virus disease in Fresno and Tulare Counties. Both groups agreed upon the identity of the virus, namely sugarcane mosaic that readily infected johnsongrass, but apparently disagreed upon the length of time the disease has been present in California (4, 5, 10, 11).

Seed transmission of SCMV-Jg at a very low percentage was reported in 1965 in both field corn and sweet corn (12).

SURVEYS

In 1964 and early 1965, limited surveys were made independently by California Department of Agriculture and county agricultural commissioners' personnel and by University of California research and extension personnel. The main activity was in Fresno, Tulare, Kern, and Los Angeles Counties.

Later in 1965, an intensive survey was undertaken as a cooperative project between California county departments of agriculture and the Bureau of Plant Pathology of the California Department of Agriculture. Arrangements were made with R. J. Shepherd, plant pathologist at the University of California, Davis, to confirm finds of SCMV-Jg as they were encountered in new areas or naturally on new hosts; with J. H. Freitag and N. W. Frazier, entomologists at the University of California, Berkeley, to test suspects of corn stunt virus and maize leaf fleck virus; and with California Bureau of Plant Pathology laboratory personnel for identification of mechanically transmitted viruses (by use of indicator host plants) when the field diagnosis was in question.

Corn was chosen as the primary crop for detection of the virus diseases in question, with grain sorghum and sudangrass serving as secondary crops to be surveyed. Timing of the survey was planned to coincide with the period when the majority of the first plantings in a county would be in the pretassel to pollination stage of development (varying from May to August). In southern San Joaquin Valley and southern California, additional surveys were made on later plantings.

Surveys of corn virus diseases were made in 35 counties, thus covering all counties having more than 20 acres of sweet corn or 100 acres of field corn, except Humboldt County.

CORN VIRUS DISEASES OBSERVED

The only virus disease of corn collected during the surveys in 1964 and 1965 was sugarcane mosaic virus. Two strains of the virus were encountered: sugarcane mosaic virus (SCMV) and a strain of sugarcane mosaic virus that infects johnsongrass (SCMV-Jg). The presence of corn stunt virus was not confirmed. Cucumber mosaic virus on corn was not observed. The presence of maize leaf fleck virus was not confirmed.

Plants of sweet corn displaying leaf fleck symptoms in 1965 were collected in the same locality from which leaf fleck was collected in 1946 (14). Aphid transmission tests from these plants, conducted by Freitag and Frazier at Berkeley, were not successful.

DISTRIBUTION OF SUGARCANE MOSAIC VIRUSES IN CALIFORNIA

SCMV was found in small plantings of sugarcane in Fresno, Madera, and Orange Counties; in corn and sorghum planted immediately adjacent to infected sugarcane in Fresno County; and in corn in Dairy Valley in Los Angeles County.

SCMV-Jg was found in the San Fernando Valley of Los Angeles County and in the San Joaquin Valley from Kern County to the San Joaquin-Sacramento River Delta. It was also found in two separate locations in the Sacramento Valley, one in Yolo County and the other in Butte and Tehama Counties (fig. 1). This strain of the virus occurred naturally in the field in the following grass species: *Digitaria sanguinalis* (L.) Scop., *Echinochloa crusgalli* (L.) Beauv., *Eragrostis diffusa* Buckl., *Eriochloa gracilis* (Fourn.) Hitchc., *Setaria lutescens* (Weigel) Hubb., *Sorghum halepense* (L.) Pers., *S. sudanense* (Piper) Stapf., *S. vulgare* Pers., and *Zea mays* L. Johnsongrass, *Sorghum halepense*, is the only perennial species.

Although Shepherd (10) reported a winter annual, *Bromus mollis* L., susceptible to inoculation with SCMV-Jg, symptoms have not been observed in the field on annual or perennial grasses that grow during the winter months.

In early spring mosaic symptoms were found on a few volunteer corn plants grown from recently plowed-under corn at one location and also on sprouts from stubble of grain sorghum at a second location. However, in both cases infected shoots of johnsongrass adjacent to the fields were already up and colonized by aphids.

FIELD SYMPTOMS OBSERVED

Generally the main symptoms of SCMV-Jg observed were the variations of the mosaic that has already been adequately described and pictured in other publications (4, 10). Occasional plants were encountered which showed only stripes which were centered on the secondary veins, a symptom pattern that has been suggested to be more characteristic of a leafhopper-transmitted corn virus (7). Plants of this type submitted to Frazier and Freitag at Berkeley yielded only SCMV-Jg which produced only the typical mottle on test plants. Transmission tests with the leafhopper, *Dalbulus maidis*, were negative (5).

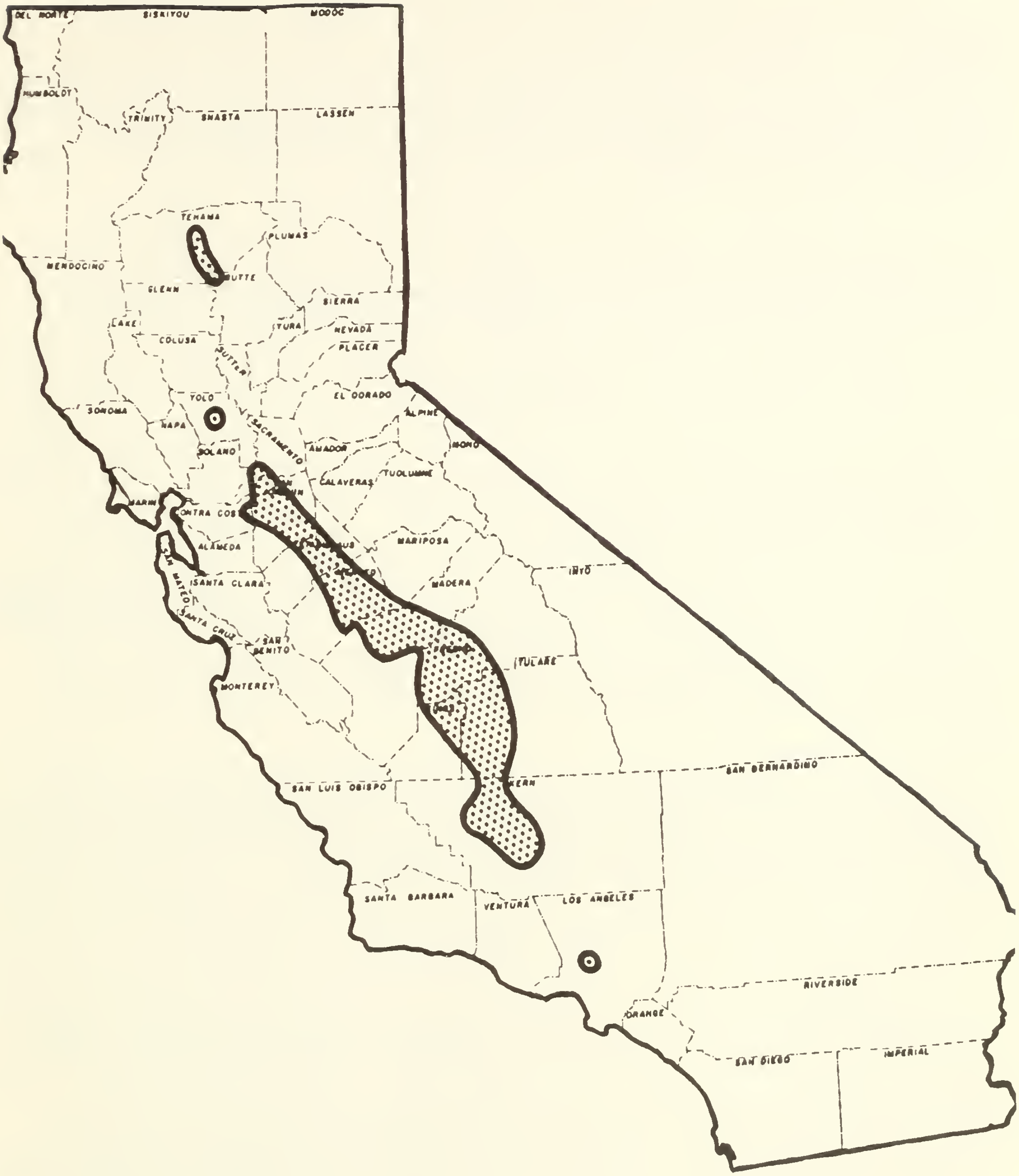

FIGURE 1.--Distribution of the johnsongrass strain of sugar cane mosaic virus indicated by dotted areas, California, 1965.

Necrosis was observed on some varieties of sweet corn, field corn, grain sorghum, and forage sorghum. On corn, for example, FM Cross, the necrosis was expressed as buff-colored necrotic areas, usually appearing first on the most chlorotic areas of the plant. As the plant matured, the necrosis became more extensive, occasionally involving the entire upper part of the stalk, thus simulating symptoms that might suggest a root rot problem. Root necrosis was observed on plants that showed a necrotic reaction.

In two instances sorghum plants were observed that, in addition to the mottle in the new growth, showed red to reddish-brown blotches, streaks, or zonate spots and later necrosis on the maturing leaves. This necrotic type of reaction of sorghum to a virus has been noted before (*1*, *2*, *6*, *9*).

LOSS ESTIMATES

Experimental data on which to base estimates are not available; therefore, the author has used his own judgment here for evaluating yield reductions in the different types of corn.

The loss in corn yield in California in 1965 due to SCMV-Jg is estimated at about $112,570, a figure which includes $100,960 for sweet corn, $8,480 for field corn grown for grain, and $3,130 for field corn grown for silage. The number of acres that would be needed to replace the losses in yield for sweet corn, grain, and silage are 400, 36, and 28 acres, respectively.

The major part of this loss, $93,300, was sustained by only 10 sweet corn growers, 9 in the San Fernando Valley of Los Angeles County and 1 in eastern Fresno County. The comparatively small loss in field corn is probably due to the fortunate wide use of resistant varieties.

HOST RANGE STUDIES

Systemic infection of 10 species of grasses following mechanical inoculation with SCMV-Jg has been reported by Shepherd (*10*). He also reported negative results for 25 additional grass species, including sugarcane. Limited mechanical inoculations made by the author, using an isolate from Merced County, adds additional species which reacted with systemic symptoms: *Eragrostis diffusa* Buckl., *Imperata brevifolia* Vasey, *Panicum dichotomiflorum* Michx., *Saccharum officinarum* L., *Sorghum almum* Parodi, *S. lanceolatum* Stapf., *S. virgatum* (Hack.) Stapf., and a natural sorghum X johnsongrass (triploid) hybrid. Three of these species and the hybrid are potential perennial reservoirs.

A single plant of an unknown sugarcane variety, locally known as Hawaiian Red, became systemically infected with mosaic following aphid contamination of a screened house used to hold isolates of both SCMV and SCMV-Jg. Repeated transfers from this plant to johnsongrass were successful, whereas transfers from a naturally infected sugarcane variety, locally known as Blue, were not. Previous inoculations with juice from infected johnsongrass made on vigorous plants over 1 foot tall, of both varieties, had been unsuccessful. Subsequent inoculations of vigorous suckers grown from one-node seed pieces were successful on variety Hawaiian Red.

Sugarcane seedlings of three different crosses, CP52-68 X CP38-34, Co421 X CP53-17, and CP52-68 X Q58, were mechanically inoculated with juice from infected johnsongrass 2 months after seeding in the first test and 1 month after seeding in the second test. The numbers of seedlings that showed systemic symptoms out of the total number of seedlings were 16/41, 9/39, and 0/16, respectively, in the first test and 9/23, 17/41, and 6/21 in the second test.

Sixteen seedlings of the cross, CP52-68 X CP38-34, showing symptoms were potted and held for observation. After 3 months, nine of these had become symptomless. No attempt has been made to recover the virus from these symptomless plants.

DIFFERENTIAL HOSTS OF SCMV AND SCMV-Jg

The two strains of the virus encountered in corn could be separated on the basis of resistance or susceptibility of johnsongrass to inoculation. A better differential was found in young sorghum seedlings grown from self-pollinated seed of a single selected plant of variety Martin's RS608. In the greenhouse about 75 percent of these seedlings produced red necrotic blotches, stripes, or zonate spots following inoculations with either strain. In addition to necrosis, SCMV-Jg produced a mottling of the new growth while SCMV, with rare exception, did not. The necrosis plus mottle produced by SCMV-Jg resembles the reaction pictured by Dale in Arkansas (1), while the necrosis alone produced by SCMV is characteristic of symptoms described for sorghum red stripe disease in Europe (9).

Preliminary inoculations suggest that the two sugarcane varieties mentioned above may be differential hosts, each being susceptible to one virus strain but not to the other.

REMARKS

The magnitude of loss in sweet corn may be expected to increase as the virus spreads into and builds up on johnsongrass in the widely scattered sweet corn growing areas of the State and until such time that adaptable resistant varieties are found and are made available to the growers.

Little or no increase in loss in field corn is expected since resistant field corn varieties and breeding lines are available. Most of the damage in field corn will be limited to fields in which highly susceptible varieties are grown.

ACKNOWLEDGMENT

I am grateful to the inspectors, both county and State, for their assistance in the surveys that supplied most of the information and material upon which this report is based; and to fellow agriculturalists in the agricultural extension service and the California Department of Agriculture for their assistance and encouragement. Special thanks is extended to: R. J. Shepherd, plant pathologist, University of California at Davis; N. W. Frazier and J. H. Freitag, entomologists, University of California at Berkeley; C. A. Loos, plant pathologist, Los Angeles County Department of Agriculture; and W. O. McCartney and R. M. Pratt, plant pathologists, California Department of Agriculture.

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GEORGIA.

THE CORN VIRUS SITUATION IN GEORGIA IN 1965[1]

George M. Kozelnicky[2]

A survey, similar to the one in 1964 (2), was conducted in the summer of 1965 to determine the prevalence and identity of viruses affecting corn. Results of the survey[3] are given elsewhere in this summary.

During the survey, plants exhibiting virus symptoms were dug and their roots placed in plastic bags to keep them alive. Plants were collected from 12 counties widely distributed in the State. Sap from young leaves from these plants was used to inoculate 3- to 5-inch seedlings of the single-cross corn, C1 X C2, growing in nonsterile soil in 6-inch plastic pots. This single cross was adopted as a tester plant for virus determinations by plant pathologists at the 1965 Southern Corn Improvement Conference (1). The choice was made at a time when little was published of tester plants being used by workers elsewhere. It was known that this single cross exhibited symptoms under South Carolina conditions.

Sap from leaves ground in 0.01M neutral PO_4 buffer was used to inoculate plants from July 16 through July 24. Buffer solution was not applied to the control plants. Unfortunately, inoculating two of three seedlings per pot proved unsound because all plants in each pot reacted similarly. However, control pots containing plants of the same age were available for comparison.

The plants were observed daily until October. Symptoms resembling those induced by some viruses affecting corn were seen during the 2-week postinoculation period. These symptoms were diffuse chlorotic striping, mottling, paleness, and slight pigmentation but were not sufficiently distinct to permit a definite conclusion as to viral cause. When the plants were 2 feet tall, there was a marked retardation in plant height of inoculated plants.

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[1] Contribution from the Department of Plant Pathology and Plant Genetics, College Experiment Station, University of Georgia, College of Agriculture Experiment Stations, Athens, Ga. 30601. Published with the approval of the Director as Journal Paper No. 495.

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[3] Dr. W. Garrett, Head, Extension Plant Pathology, and Dr. W. J. Wiser, Corn Breeder, Georgia Coastal Plain Agricultural Experiment Station, Tifton, Ga. 31794, aided in the survey.

When both inoculated and check plants were 24 to 36 inches tall, they were transplanted to a greenhouse ground bed to observe growth to maturity. Two weeks after transplanting, accelerated growth occurred. Inoculated plants showed spindly growth of the stalk and an increase in the length and number of brace roots as high as the sixth node. Early lodging also occurred in inoculated plants and they grew to maturity in a procumbent condition. Control plants matured normally. As far as can be determined, this type of lodging has not been described for either corn stunt, maize dwarf mosaic, or other corn virus diseases.

Measurements were made of stalk circumference at the first, fourth, and sixth internodes and of total plant height. These data are presented in table 1.

Table 1.--Measurements of some characteristics of C1 X C2 single-cross corn plants inoculated with expressed juice from apparently virus-affected corn plants in 1965 and of non-inoculated control plants

Treatment	Total plants	Plants lodged	Mean plant height	Circumference		
				First internode	Fourth internode	Sixth internode
	Number	Number	Inches	Inches	Inches	Inches
Inoculated----	117	74	65.4	0.535	1.207	1.395
Uninoculated--	58	0	96.6	1.618	2.149	2.146

The data show that inoculated plants were affected by a mechanically transmissible agent. There was a marked difference in plant height (stunting) of 31.2 inches between inoculated and uninoculated plants. There were also distinct differences in internodal circumferences.

The plants were still green at harvest, and a number of stalks selected at random were stored without identification in a cold room at 3°C. At the time the initial mechanical transmissions were made, young leaves from seemingly affected plants from two counties were sent to Dr. E. Rosenkranz at the Corn Virus Laboratory at Starkville, Miss., to determine whether corn stunt virus was involved. Tests conducted with the vector, *Dalbulus maidis*, proved negative.

Consultations were held with colleagues at the 1966 Southern Corn Improvement Conference. As a result, mechanical transmissions were attempted with juice extracted from stalks stored 4 months earlier.

The testing spectrum of corn plants was broadened to include Golden Bantam sweet, Ohio W49, Moews MCB98W, and Cl X C2. KSN soybeans and Straightneck squash were included to test possible presence of other viruses. No symptoms developed on these broadleaf plants. Only Golden Cross Bantam showed symptoms of maize dwarf mosaic when inoculated with the juice from stalks. Symptoms on the other testers were as indistinct as those of the test during the previous summer, especially on Cl X C2. Two additional tests were also inconclusive in which two sources of virus, other than the Georgia strain were used, both being maize dwarf mosaic. All virus sources have shown less effectiveness after storage.

It is concluded that:

1. The virus complex in corn in Georgia is due partly to a mechanically transmissible agent that causes symptoms resembling maize dwarf mosaic.

2. Even though mechanical transmission was successful, the naming of definite sites of infection was not possible. The virus source was drawn from a composite of plants from 12 counties.

3. Maize dwarf mosaic was not detected in tests in the summer of 1965, probably because of the use of a single partially resistant hybrid Cl X C2.

4. Extreme spindliness of stalk, which resulted in plants maturing in a procumbent position, was observed under greenhouse conditions. This symptom has not been described previously for either maize dwarf mosaic or corn stunt.

5. There is evidence that the transmissible agent is active when extracted from mature stalks after cold storage for 4 months. However, its activity decreases upon storage.

6. Corn stunt disease has not been demonstrated in Georgia.

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ILLINOIS

CORN VIRUS SURVEYS AND INVESTIGATIONS FOR 1965[1]

H. H. Thornberry[2]

"Typical leaf mottling (mosaic) of young corn, Johnson grass, and gamagrass is a symptom of maize dwarf mosaic that is recognizable by field inspection and is reliable for rapid field diagnosis of the disease.

"Maize dwarf mosaic was found in Illinois in 1965 in 14 counties. The virus was not detected in specimens from 32 counties, although the disease may have been present in these or other counties.

"Annual spread of this disease within Illinois is yet undetermined. Increase of known infested areas from one county (7 counties according to diagnosis by symptoms) in 1964 to 14 counties in 1965 does not necessarily indicate disease spread, since the 1964 survey was not sufficiently extensive to determine the full occurrence of the disease. It is assumed that it occurred in Pulaski County, although the virus was not detected in specimens received for examination.

"The virus was spread locally from overwintering reservoir plants (infected perennial plants) to corn. (Virus is transmitted by insect vectors -- aphids are known vectors.)

"The disease was most severe and intense in the southernmost counties.

"Corn loss due to the disease was estimated to be about 187,000 bushels -- about 0.7% of the 25,318,500-bushel 1964 production in the 15 counties in which the virus was found or assumed to be present, or about 0.026% of the 710,892,000-bushel 1964 production in the state.

"Virus reservoir plants found to be naturally infected were Johnson grass and gamagrass. The virus was not detected in 24 other species of plants exposed to the virus by natural spread."

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[1] Excerpts from a mimeographed report on field survey and laboratory diagnosis of maize dwarf mosaic in Illinois issued November 1965.

[2] Professor, Department of Plant Pathology, University of Illinois, Urbana, Ill. 61801.

INDIANA

MAIZE DWARF MOSAIC IN INDIANA IN 1965

A. J. Ullstrup[1]

In 1964 MDM was found in and recovered from corn in 10 counties on the Ohio River (CLARK, CRAWFORD, DEARBORN, FLOYD, HARRISON, JEFFERSON, OHIO, PERRY, SPENCER, and SWITZERLAND).[2] The disease was also found in and recovered from corn in Tippecanoe County. There was no MDM at this site either on corn or wild hosts in 1965.

In 1965 MDM was found in and recovered from corn in 12 counties in Indiana. Sullivan and Shelby Counties are new locations. MDM was not reported here in 1964. In both locations johnsongrass was abundant and infected. Infection on corn in both places was moderate.

The disease was limited and of little economic importance in 1965 in Indiana as a whole.

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[1] Professor of Plant Pathology, Department of Plant Pathology, Purdue University, Lafayette, Ind. 47907.

[2] County names are listed from a map accompanying a letter report.

IOWA

[Letter report][1]

R. E. Ford[2]

"Recovery of MDMV from plants taken in Fremont county is certain. The determination was based on symptoms, transmission, serology, and electron microscopy. Symptoms (alone)[3] are inadequate and tell you nothing about the identity of the virus."

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[1] Excerpts from letter.

[2] Associate Professor, Department of Botany and Plant Pathology, Iowa State University, Ames, Iowa 50010.

[3] Added for clarity.

KANSAS

[Letter report][1]

W. H. Sill, Jr.[2] [3]

"During the summer of 1965 many samples of supposed virus infected corn were sent to our laboratory from various parts of the State. Thus far, only one collection has been mechanically transmissible to corn and Sudan grass. It came from the U. S. Detention Barracks Penal Farm at Fort Leavenworth in extreme northeastern Kansas on the Missouri River Bottom. Two large clumps of Johnson grass that showed clear symptoms were found. Corn plants were infected around the Johnson grass and showed typical maize dwarf mosaic virus symptoms. Tissue of both infected species was collected and carried to Manhattan (Kansas) where mechanical inoculations were made to diagnostic hosts, wheat (cv. Pawnee), soybean (cv. Harosoy 63), corn (cv. Stowell Evergreen), summer squash (cv. Early Yellow Prolific Straightneck), and Sudan grass. The virus infected only the corn and Sudan grass. (The symptoms were similar to those of maize dwarf mosaic in these hosts).

"Even though positive transmission was achieved from only one source during the summer, other small diseased spots probably were present in corn grown in the Missouri and eastern Kansas river valleys. Johnson grass, the perennial host (of MDMV), is relatively common in eastern Kansas but not nearly so abundant as it is to the south and east. In many areas where Johnson grass occurs in occasional small patches, it could be eliminated with relative ease. Since it is not an important grass in the State, this has been recommended in the hope that the movement of this potentially severe disease into Kansas can be delayed or possibly stopped."

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[1] Excerpts from a letter (1965) portions of which were later published in U.S. Agr. Res. Serv. Plant Dis. Rptr. 50: 11.

[2] Professor of Plant Pathology, contribution No. 491, Department of Plant Pathology, KAES, Kansas State University, Manhattan, Kans. 66502.

[3] Parenthetical additions made by the compiler for clarity.

KENTUCKY

[Letter report]

E. M. Johnson[1]

"Maize dwarf mosaic was found in 22 additional counties in Kentucky in 1965. Successful mechanical transfers were made to corn in the greenhouse from all specimens collected in 1965. All mechanical transfers from virus-affected corn to Red Coat wheat were negative. Maize dwarf mosaic is now known to occur in 35 counties in Kentucky."

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[1] Formerly Professor, Department of Plant Pathology, University of Kentucky, Lexington, Ky. 40506.

LOUISIANA

VIRUS DISEASES OF CORN IN LOUISIANA

Thomas P. Pirone[1], Travis R. Everett[2], and William P. Bond[3]

SUMMARY

Sugarcane mosaic virus and a virus causing stunting, leaf reddening, or both affect field-grown corn in Louisiana. Preliminary studies showed that the stunting virus was not mechanically transmissible, and that plants grown under screened cages in the field did not develop the disease, indicating that it was probably insect transmitted.

In the greenhouse, corn seedlings fed on by *Graminella nigrifrons* collected in and around fields containing severely stunted plants developed stunting, leaf reddening, and, in some cases, leaf splitting and chlorotic leaf symptoms, similar to those produced by corn stunt. Transmission was low in most cases. Nonviruliferous *G. nigrifrons* colonized on these plants for 3 to 4 weeks transmitted the virus when transferred to healthy corn seedlings. *G. nigrifrons* has also been found to be a vector of true corn

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[2] Associate Professor of Entomology, Department of Entomology, Louisiana State University, Baton Rouge, La. 70803.

[3] Research Assistant, Department of Plant Pathology, Louisiana State University, Baton Rouge, La. 70803.

stunt. These facts suggest that the virus causing stunting in corn in Louisiana may be a strain of the corn stunt virus.

Plants grown under screened cages, in the field, developed symptoms precisely like those of the stunting disease, when viruliferous _G. nigrifrons_ were introduced into the cages. Plants caged without these insects remained healthy.

Mosaic-infected johnsongrass was found in one location in Louisiana in 1966. Thusfar, maize dwarf mosaic has not been found on corn, nor is mosaic infected johnsongrass associated with fields of stunted corn.

INTRODUCTION

The stunting disease of corn first reported from Louisiana in 1964 (_1_) has some resemblance to corn stunt (_5_) as well as to the maize dwarf mosaic (MDM) disease present in the Midwest (_8_). The results of attempts to transmit and identify viruses associated with diseased corn in Louisiana are outlined in this paper.

MATERIALS AND METHODS

Mechanical transmission tests.--Areas in Pointe Coupee and Rapides Parishes, in which the stunt disease has been widespread in recent years, were sampled periodically beginning in mid-April of 1965. Three statewide surveys, concentrating on parishes along the Arkansas border and along the Red and Mississippi Rivers, were made at monthly intervals beginning May 30. The northern part of the Red River Valley in Bossier and Caddo Parishes was intensively sampled, as this region is the closest to areas in Arkansas from which MDMV has been reported.

Leaves of corn and johnsongrass plants showing any type of symptoms resembling mosaic were harvested and placed in plastic bags in a cooler until tested at Baton Rouge. All samples were mechanically inoculated to sorghum seedlings, and isolates infecting sorghum were tested on corn, johnsongrass, sorghum, and sugarcane seedlings. Infection of johnsongrass was considered to be diagnostic of MDMV. Transmission tests from stunted corn with red leaves were made directly to corn.

Screened-cage tests.--To determine whether the disease was being transmitted by insects, sweet corn seedlings were planted under 4- by 6- by 4-foot cages covered with 32-mesh Saran screen. As controls, plants were caged under cages designed to provide the same amount of shading but in which openings were provided, by offsetting the screening, to allow the entrance of insects. Uncaged plants and plants treated with systemic insecticide were also included in the test. Five replications, of four plants each, were made of each treatment.

Insect transmission tests.--Two types of leafhopper transmission tests were made. In the first, nonviruliferous *Graminella nigrifrons* (Forbes) and *Dalbulus maidis* (DeL. & W.) were caged with leaves taken from plants showing typical stunting and leaf-reddening symptoms. After a 24- to 48-hour acquisition period, they then were transferred to healthy corn plants. In the second, *G. nigrifrons*, collected in and around fields of stunted corn, were caged immediately on healthy corn plants. In both types of test, the insects were transferred to fresh healthy corn plants, 1 to 3 inches high, at weekly intervals. After removal of the insects, these test plants were maintained in the greenhouse until mature.

In the spring of 1967, transmission tests were made with corn grown under cages in the field. The cages and designs were as described under screened cage tests. *G. nigrifrons*, collected from grasses growing in a field with a history of stunt, were caged with 5 corn seedlings in 2 ways: (1) 100 insects were caged each week for 4 weeks, on a separate set of plants each week (total 100 insects/cage), (2) 100 insects were caged each week for 4 weeks on the same set of plants (total 400 insects/cage). Plants grown under cages which excluded insects, and plants grown without cages, served as controls.

In a single test using the aphid *Myzus persicae* (Sulz.), 75 aphids, which had been fasted for 1 hour, were allowed to probe leaf tissue from stunted, red-leaved plants for 30 to 40 seconds. They were then transferred to healthy corn seedlings for 12 hours, after which the insects were killed. The aphid *Rhopalosiphum maidis* (Fitch) was also used in one test. In this test, 65 aphids were allowed to feed on diseased plants for 6 days and on healthy plants for 7 days.

The sweet corn variety Aristogold Bantam Evergreen, which is very susceptible to the disease in the field, was used in all insect transmission tests.

RESULTS

Mechanical transmission tests.--In 1965, mechanically transmissible virus was recovered from corn showing mosaic symptoms in Madison, Ouachita, and Union Parishes in north Louisiana, and a single mosaic-infected plant was found in Rapides Parish in central Louisiana (fig. 1). In all but one

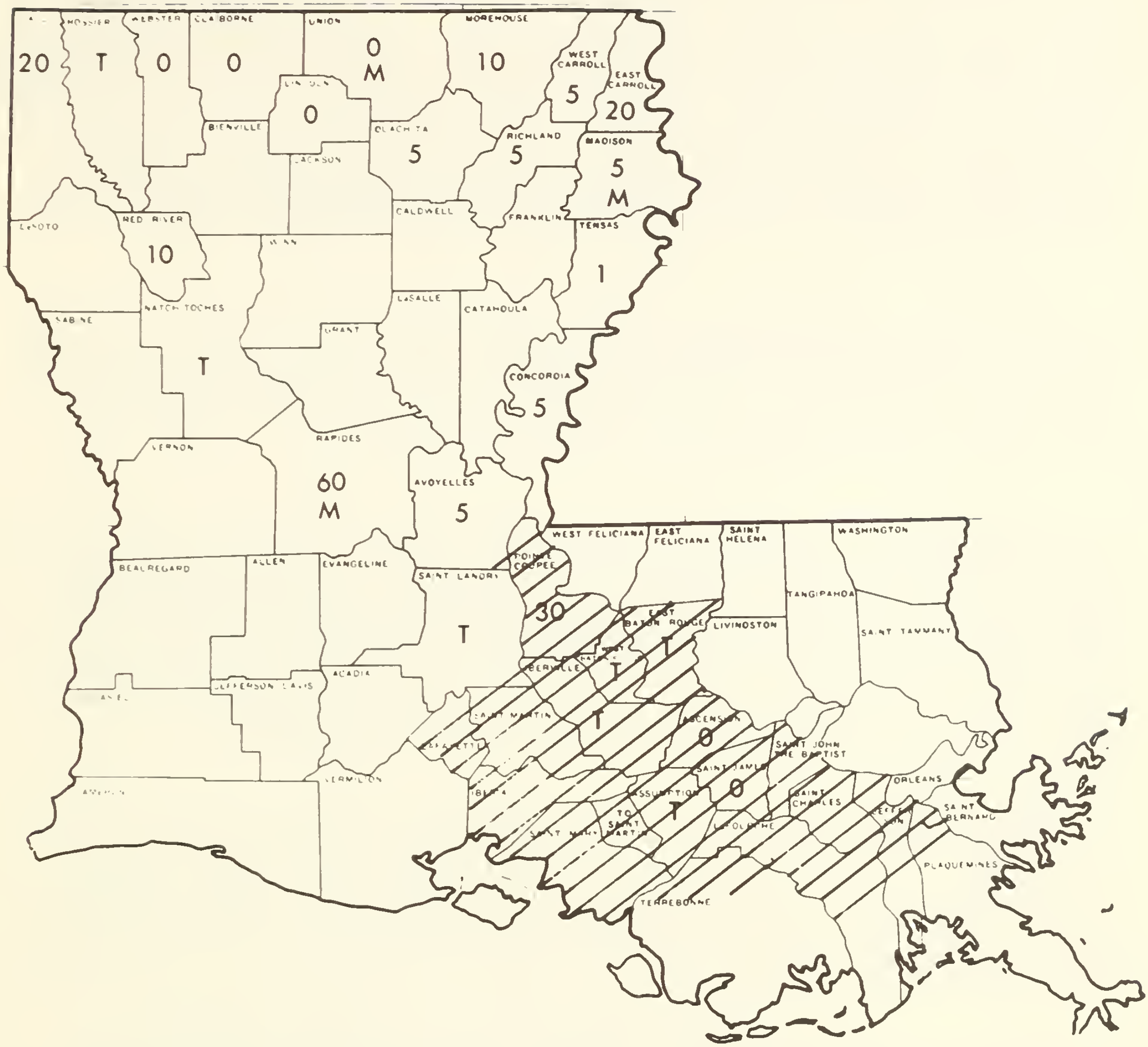

FIGURE 1.--Distribution of stunted and of mosaic-infected corn in Louisiana in 1965. Numbers refer to the highest percentage of stunted corn found in any field in a parish: 0, no stunted corn; T, less than 1-percent stunted corn. General area in which sugarcane mosaic virus (SCMV) is widespread in sugarcane and potentially in corn is indicated by hatching. Other parishes in which SCMV-infected corn was found are indicated by the letter M.

of these locations, small plantings of sugarcane infected with sugarcane mosaic virus (SCMV) were found within 200 yards of the infected corn. The one exception was in Madison Parish, where the single infected plant was over a mile from the nearest infected sugarcane. Mechanically transmissible virus could routinely be isolated from corn grown near SCMV-infected sugarcane fields in the sugarcane belt in south Louisiana (fig. 1). The viruses isolated from all these samples produced typical mosaic symptoms on sorghum, sugarcane, and corn but did not produce symptoms on johnsongrass. Strain H of SCMV also failed to produce symptoms on any of over 1,000 johnsongrass seedlings inoculated in parallel tests. No mechanically transmissible viruses were recovered from any of the johnsongrass samples taken from the field.

There was no correlation between infection of corn with SCMV and the presence of the stunting disease. In general, very few or no stunted plants were found in cornfields in south Louisiana which had high percentages of SCMV-infected plants (fig. 1). Mechanical transmission tests from stunted plants taken from mosaic-free areas were all negative.

In 1966, mosaic-infected johnsongrass was found on the levee in Alexandria (Rapides Parish). The symptoms were readily observed on small plants, as well as on young leaves of large plants. Mechanical transmission of corn, sorghum, and johnsongrass seedlings resulted in the development of typical mosaic symptoms on all species. Johnsongrass in and around fields near Alexandria, which had high incidence of stunted corn, was examined at the same time. No mosaic symptoms could be found. No mosaic symptoms were found on the corn in these fields at any stage of development.

Screened-cage tests.--The stunt disease did not develop in any of the plants under the insect-proof cages. Seventy-five to one hundred percent of the plants in the check cage plots and the uncaged plots were diseased. Systemic insecticide applied to the soil at planting time and 20 days afterward appeared to result in a delay in symptom expression but did not completely protect the plants.

Insect transmission tests.--Six greenhouse transmission experiments with *D. maidis* and five experiments with *G. nigrifrons* were made using leaves of stunted, reddened plants for virus acquisition by the leafhoppers. The numbers of insects used at the beginning of each test and those surviving at each transfer are shown in table 1. Although some of the test plants became stunted and developed red leaves, no positive transmissions which could be verified by serial transfers were obtained in these tests.

Table 1.--Survival of leafhoppers used in corn virus transmission tests

Experiment no.	Transfer number[1] [2] [3] 1	2	3	4	5	6	7	8	9	10
	Number of Dalbulus maidis alive									
1	12	10	4	0						
2	8	6	6							
3	50	46	31	27	27	25	23	19	18	18
4	100	65	49	43	31	5	5			
5	13	10	8	8	4	4	4	3		
6	20	18	15	8	2	0				
	Number of Graminella nigrifrons alive									
1	21	14	8	0						
2	45	37	10	1	0					
3	100	66	30	4	3	0				
4	20	4	1	0						
5	14	11	5	1	0					

[1] Transfers made at 7- to 8-day intervals.
[2] 5 to 10 insects per plant were used in each test.
[3] Transfer 1 is the initial transfer after a 24- to 48-hour acquisition period.

In 1966, G. nigrifrons collected in and around fields of stunted corn were placed, individually or in groups of 10, on healthy corn seedlings. Fifteen of the fifty plants receiving 10 insects per plant became stunted and had some red leaves. Some plants also had the leaf splitting and chlorotic leaf edges characteristic of corn stunt infection. Although these insects were transferred at weekly intervals to fresh test plants, only three plants became infected in the second transfer and none subsequently. These results could be explained on the basis of death of the viruliferous insects, since considerable mortality occurred after the first transfer and all insects died within 4 weeks. Of 100 plants receiving a single insect per plant, 7 became stunted. None of the checks developed stunt symptoms in these tests.

Serial transmission tests using nonviruliferous *G. nigrifrons* allowed a 1 week acquisition period on these plants were unsuccessful. All of the insects in this test died before the period found to be the minimum for incubation of corn stunt virus in *G. nigrifrons*, however.

In an attempt to overcome the difficulties encountered in obtaining insect survival, adult *G. nigrifrons* were allowed to deposit eggs on the diseased plants. The progeny were reared on these plants for 23 days and then 15 were transferred to each of 12 healthy corn plants for 1 week. Three of the test plants to which these insects were transferred became stunted and developed leaf splitting, marginal chlorosis, and some leaf reddening. Four other plants showed stunting and leaf reddening only.

In the tests in which field collected *G. nigrifrons* were caged on plants grown in the field, typical stunt symptoms were produced on 60 to 80 percent of the plants on which a total of 400 insects were caged. All of the plants receiving a total of 100 insects remained healthy, as did the control plants caged to exclude all insects. No *G. nigrifrons* were alive in the cages when the cages were removed, 2 1/2 weeks after the last insects were caged. Incidence of stunt in the corn grown in plots without cages ranged from 10 to 40 percent.

Negative results were obtained in the transmission tests with the aphids *M. persicae* and *R. maidis*.

DISCUSSION

The fact that mosaic-infected johnsongrass does occur in Louisiana indicates that MDMV may become a problem in the future. The absence of MDMV in stunted corn indicates that this virus is not a factor in causing stunted corn in Louisiana at the present time, however.

High incidence of SCMV in corn planted near infected sugarcane fields was reported as early as 1927, by Stoneberg (7), who also found that the disease had no apparent effect on the rate of growth or total height of the varieties of corn he studied.

The evidence that the disease causing stunting and leaf reddening in corn is not due to a fungal or bacterial pathogen is indicated by our inability to isolate any organisms capable of reproducing the disease from diseased plants. The disease has also developed in corn planted in methyl-bromide fumigated plots and in corn planted in containers of sterilized soil.

Although the symptoms resemble those of the Rio Grande type corn stunt (5) in some respects, the chlorotic secondary shoots are seldom found and red leaves are commonly found on infected plants. The disease found in the field in Louisiana does not show the severe stunting and branching associated with the Mesa Central type (5), although these symptoms were sometimes produced in the greenhouse.

In four of the tests made with *D. maidis*, the time which elapsed between the acquisition feeding and the final transfer to healthy corn was well in excess of the incubation period reported for corn stunt in this vector (4, 6). Furthermore, using our colony of *D. maidis* and the same techniques we have described, we have been able to transmit an isolate of true corn stunt virus, obtained from Mississippi State University, to 100 percent of the test plants within 21 to 28 days after acquisition, using five insects per test plant.

It has been reported (2) that *G. nigrifrons* and *D. maidis* are both capable of transmitting a corn stunting virus obtained from Rapides Parish, La., in 1964. The minimum incubation period of the virus in *G. nigrifrons* was 23 days, however; and few, if any, of the *G. nigrifrons* used in our tests survived this long (table 1). This might explain our negative results with *G. nigrifrons* fed on diseased corn leaves. Our failure to transmit the virus with *D. maidis* may have been due to a lack of virus in the tissues selected.

Serial transmission of virus recovered from *G. nigrifrons* collected in fields of stunted corn indicates that these insects are carrying a corn virus which causes stunting and reddening as well as leaf splitting and marginal chlorosis in some cases. The fact that typical stunt symptoms are produced when viruliferous *G. nigrifrons* are caged with corn in the field shows that this insect does transmit the virus which causes these symptoms. The reasons for the differences in field and greenhouse symptoms are not understood, however, and studies on the effect of inoculum dose, age of infection, and temperature and light relationships on symptom expression are planned.

The lack of transmission in the cages in which only 100 insects were confined per cage indicates either a low insect survival rate or that only a small percentage of the insects are viruliferous. The low percentage of transmission in the greenhouse tests, in which the survival of the insects was recorded, indicates that the latter is probably true. The fact that no insects were alive at the end of the field test indicates that survival was possibly also a factor in the low level of transmission.

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MARYLAND

[Letter report][1]

L. O. Weaver[2]

"Maize dwarf mosaic virus was found in Allegany County, Maryland in sweet corn September 17, 1965.

"The virus was transmitted into healthy corn. I would guess that the Maryland picture is similar to that in Pennsylvania. The virus (MDMV) may be further east since it is also in New Jersey." (See New Jersey section of this report.)

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[1] Excerpts from letter.

[2] Professor and State Pathologist, Cooperative Extension Service, University of Maryland, College Park, Md. 20742.

MICHIGAN

VIRUS DISEASES OF CORN IN MICHIGAN (1963-1965)[1]

A. H. Ellingboe, N. A. Smith, and J. L. Clayton[2]

Virus diseases of corn can cause serious economic losses. Because of the known prevalence and severity of virus diseases of corn in Ohio, it was considered important to determine if there were any virus diseases of corn in Michigan.

In 1963 through 1965, much corn in southern Michigan had red striping on the kernels. The cause was not determined.

In the summer of 1964, maize dwarf mosaic (MDM) was reported to be present in most counties of Ohio, including the three counties bordering Michigan. Extensive surveys were conducted in Michigan and plants suspected of having symptoms of MDM were brought into the laboratory for attempts at transmission with extracted plant juice. All attempts were unsuccessful. Two known johnsongrass areas were also examined for the presence of the virus, both by visual examination of foliar symptoms on johnsongrass in the field and grown in greenhouses from rhizomes and by transmission studies. No virus could be demonstrated to be present in johnsongrass.

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[1] Published with the approval of the Director, Michigan Agricultural Experiment Station, as Journal Series Article No. 3773.

[2] Associate Professor of Botany and Plant Pathology, Associate Professor of Plant Pathology and Extension, and Agricultural Research Technician, respectively. Department of Botany and Plant Pathology, Michigan State University, East Lansing, Mich. 48823.

In 1965, additional extensive surveys were made and again a demonstration of the presence of a disease transmissible by means of expressed juice was not achieved.

Because of the apparent nearness of MDM in Ohio to Michigan and indications in earlier years of the rapid rate of spread of MDM, Dr. Elmer Rossman planted Michigan-adapted corn varieties and breeding material in the MDM nurseries at Portsmouth, Ohio. Ears were collected from 150 plants, which showed varying degrees of susceptibility, tolerance, or resistance in the MDM nurseries. Ten seeds from each of the 150 plants were planted in 7-inch pots in the greenhouse at East Lansing. If the virus was seed transmitted, the seedlings should show symptoms and the disease should be transmissible with expressed plant juice.

Mottling was apparent on the first, second, and third leaves of some plants. Most plants had no disease symptoms. Attempts to transmit the apparent disease of 24 plants with expressed plant juice to two varieties of corn (M92 X 93 and Golden Cross Bantam) and two varieties of wheat (Little Club and Red Coat) were unsuccessful. The transmission studies were repeated with the same results.

These studies indicate that the MDM virus is not present in Michigan and that it is not transmitted through the seed. The latter is considered of particular significance for two reasons: (1) The possibility of plant contamination in the greenhouse can be definitely ruled out, because the virus was not anywhere in the greenhouse; and (2) evaluation of breeding material in geographic areas where the disease is present is possible, without certainty of bringing the disease into Michigan with the seed saved from these tests. The presence of virus 3A (1) in Michigan and the cause of red striping on corn kernels have not been definitively determined.

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CORN VIRUSES IN MISSISSIPPI IN 1965

E. E. Rosenkranz[1], W. A. Douglas[2], and H. N. Pitre, Jr.[3]

The presence of two distinct viruses capable of causing disease of corn in Mississippi was established in 1965. Corn stunt, observed in the State each year since 1962, was the major disease of corn in 1965. A virus-producing mosaic-type symptoms on corn and johnsongrass also has been recovered and may contribute to crop losses in the State.

Generally, corn virus diseases were as widely distributed in 1965 as in the previous season, but the rate of spread was slower than in the 3 preceding years. Corn stunt was found in one county in the southern part of the State which had been free of the disease until this summer. In areas where infection with corn stunt virus had been severe, the disease became localized in 1965. Containment of corn virus diseases in these areas may be attributed to the growing of commercial hybrids which showed resistance in field tests during the preceding season. Over the State as a whole, the distribution of corn virus diseases resembled more that of 1963 than of 1964 when the spread was phenomenal.

Corn exhibiting symptoms of stunt was first observed in the Yazoo City area on May 12. A virus, mechanically transmissible to corn, had previously been recovered from johnsongrass in Yazoo County on April 15. Later, a mosaic-type symptom was observed on corn in an experimental planting at State College (Oktibbeha County) on July 28. Both of the latter two virus isolates could be transmitted by manual inoculation to different types of corn as well as to johnsongrass and other indigenous grasses.

Positive identification of corn stunt virus was made by transmission with Dalbulus maidis from the following counties: Oktibbeha, Yazoo, Monroe, Hinds, and Covington. On the basis of symptoms alone, corn stunt was present in varying degrees in all nine of the agricultural districts of the State and most likely in all the corn-growing counties in the northern two-thirds of Mississippi.

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[2] Entomologist, Entomology Research Division, Agricultural Research Service, U.S. Department of Agriculture, State College, Miss. 39762.

[3] Assistant Professor, Department of Entomology, Mississippi State University, State College, Miss. 39762.

During 1965 the migratory nature of *Dalbulus maidis* was verified by collections carried out in several States. Eight specimens of *D. maidis* were collected in the lower Rio Grande Valley of Texas on January 8, 1965. This vector of the virus was collected in Louisiana on July 21, in Mississippi (Redwood, Warren County) on August 12, and in western Alabama on August 30. The absence of *D. maidis* early in the season in the Southeastern States and the sequence of its appearance in collections made in the various States during late summer and early fall suggest that this leafhopper migrates from the southwestern part of the United States, and possibly Mexico, in a northeasterly direction. A similar pattern of apparent migration of this species had already been observed in 1964.

Since the known vector of corn stunt virus in the United States occurs in this area only late in the growing season and the disease is prevalent early in the season, other vectors of the virus remain to be determined. Thus extensive transmission trials for corn stunt virus were carried out for purposes of both disease identification and in search for additional vectors of the virus. Eighty-one insect species were collected on corn in Mississippi during 1965, 37 of which were leafhoppers. No consistently satisfactory transmission has been obtained with any of the species tested in the greenhouse. However, results from preliminary tests with *Graminella nigrifrons* in May 1965 indicated that this leafhopper is probably an inefficient vector of corn stunt virus.

Cultures of *Dalbulus maidis* have been maintained at State College since July 1964. In order to be certain that nonviruliferous leafhoppers were available for these transfer trials, subcultures were established from isolated eggs of the leafhopper. *Dalbulus maidis* in all stages of development, from 2-day old nymphs to adults, were used in the trials. Transmission tests were performed in the greenhouse and in the field. Twelve samples of diseased corn from Alabama and six similar samples of corn from Ohio yielded negative results with *D. maidis*. Transmission trials with corn specimens received from Georgia, South Carolina, and North Carolina gave inconclusive results. In a few instances some abnormal condition, consisting of chlorosis and reduced plant height, was being transmitted with *D. maidis* which, however, did not represent typical corn stunt symptoms.

In vector studies, transmission of corn stunt was attempted under rigorous conditions with the following leafhoppers collected from corn: *Stirellus bicolor*, *Exitianus exitiosus*, *Deltocephalus flavicostus*, *Draeculacephala portola*, *Macrosteles fascifrons*, *Graminella nigrifrons*, and *Dalbulus maidis*. Transfer of viruslike symptoms was obtained with *Graminella nigrifrons*, *Deltocephalus flavicostus*, *Exitianus exitiosus*, and *Dalbulus maidis*. After a long incubation period, chlorosis developed on the leaves and was followed by yellow, red, and purple discoloration. However, no plants developed what are known as typical corn stunt symptoms. *Dalbulus maidis* was then used in an effort to transfer this abnormal condition to healthy corn plants as a part of the recovery process. The only second transfer in this attempted serial transmission was obtained when *D. maidis* was used in both the first and the second steps of the transmission test. Thus it is tempting to speculate that a virus complex which could be separated out by different species of insects may be present in Mississippi.

Dalbulus maidis apparently is not able to survive the winter in the northern two-thirds of Mississippi. Therefore, the presence of another overwintering vector(s) or a perennial host(s) of corn stunt virus is, by necessity, a distinct possibility. Host range studies with *D. maidis* in the greenhouse revealed acceptance of many species in the Gramineae for food and oviposition. However, the host range (i.e., plant species on which life cycle is completed) has been extended to include only one additional species, namely gamagrass (*Tripsacum dactyloides* L.).

MISSOURI

DISTRIBUTION OF CORN VIRUS DISEASES IN MISSOURI

M. L. Fairchild and J. H. Chandler[1]

The Departments of Entomology and Field Crops in conjunction with the Extension Service of the University of Missouri conducted surveys to determine those counties within the State having cornfields displaying symptoms of virus infection.

The Extension Service devised and distributed questionnaires to all county agricultural agents and to other University personnel. They were requested to report on the occurrence of infected fields within their area.

Dr. O. P. Sehgal of the Field Crops Department made mechanical transmission with infected plants obtained from several localities within the State. His work established the presence of maize dwarf mosaic in Boone, Cole, and Jefferson Counties. No transmission experiments have been attempted using leafhoppers and infected plants to determine if corn stunt virus is present.

The Entomology Department made extensive roadside surveys (principally south of the Missouri River) to check for fields showing virus infection. No attempts were made to determine if these infected plants showed symptoms of maize dwarf mosaic or of corn stunt.

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[1] Professor and Technician, respectively, Department of Entomology, University of Missouri, Columbia, Mo. 65202.

The frequency and severity of infections were greater in lowlands along major drainages and within poorly cultivated fields bordering the Ozark Plateau. Johnsongrass was present within most fields showing symptoms of the disease(s).

NONSEED TRANSMISSION OF MAIZE DWARF MOSAIC VIRUS FROM INFECTED JOHNSONGRASS PLANTS

Oscar H. Calvert[1/]

Thirty-six johnsongrass (Sorghum halepense (L.) Pers.) plants showing the distinct mosaic-pattern symptoms of the maize dwarf mosaic virus were tagged in a farmer's cornfield in Jefferson County, Mo., in June 1965. Many of these plants harbored corn leaf aphid (Aphis maidis) colonies. Two seed sets were harvested (August 3, 1965, and September 24, 1965). The seed was cleaned and separated from the seed heads and classified into first- and second-grade seed by size. Five-seed samples of each grade were chosen from each plant, dehulled, and placed on moist blotters in petri dishes at 20°C. for germination (1, 2, 3). Some 209 seed sprouted and 199 were transplanted to 4-inch plastic pots containing a mixture of Terralite vermiculite and builder's washed river sand (3:2 ratio) and grown for 30 days in a walk-in plant growth chamber with controls set for a 12-hour photoperiod, 20°C. "night" and 30°C. "day," and 50 percent minimum relative humidity. Hoaglands modified (Sesquesterine Iron Chelate) mineral-nutrient solution was substituted for daily watering with distilled water once each week. No insects were observed, but Malathion was sprayed on the plants weekly.

Leaf samples were collected from 20 randomly selected plants, and the juice was expressed from each sample in a mortar and pestle. A small amount (5-10 ml.) of a pH 7.0 buffer (Na_2HPO_4-NaH_2PO_4, 0.1 molar) was mixed with the juice, and the mixture was rubbed on two Stowell evergreen hybrid sweet corn seedlings in the third-leaf stage. The upper leaf surfaces of the corn seedlings were sprinkled with 600-mesh carborundum powder to facilitate inoculation.

None of the johnsongrass samples showed any evidence of virus infection, and none of the inoculated sweet corn seedlings produced virus symptoms. After 14 days, the corn seedlings were assumed to be free from any seed-transmitted virus such as the mechanically transmitted maize dwarf mosaic.

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NEW JERSEY

OCCURRENCE AND TRANSMISSION OF MAIZE DWARF MOSAIC ON SWEET CORN IN NEW JERSEY[1]

P. M. Halisky, M. W. Siddiqui, and J. C. Anderson

In September 1965, a sap-transmissible virus associated with mosaic symptoms in sweet corn was collected in four fields in Burlington County, N. J. These fields were located along U.S. Highway 206 between Bordentown and Indian Mills. During the initial isolation of the virus from these four fields, the number of sweet corn test plants that became infected (numerator) and the number of plants inoculated (denominator) were 17/17, 20/23, 12/12, and 11/12, respectively. Plant specimens from five other cornfields showing red-leaf symptoms proved negative in transmission tests. The symptoms of both naturally infected plants in the field and sap-inoculated plants in the greenhouse resembled those of maize dwarf mosaic as described and illustrated in Ohio Research Circular 137 (1).

TRANSMISSION STUDIES

Transmission studies with the New Jersey corn virus were conducted in a greenhouse maintained at 70° to 75°F. Stowell Evergreen sweet corn was used throughout as the test plant. Seedlings 10 to 14 days old were inoculated by rubbing homogenates of infected tissue over healthy leaves previously dusted with #500 grit aluminum oxide carborundum powder. The diluent used for macerating tissue was a 1 percent dibasic sodium phosphate--1/2 percent sodium sulfite solution at pH 7.8. Mosaic symptoms usually appeared 7 to 10 days after inoculation in sweet corn and 14 to 21 days after inoculation in sorghum depending on variety. The results of sap-transmission studies with differential test plants are shown in tables 1 and 2. All symptomless plants listed in table 2 were further assayed on sweet corn seedlings and found negative. Three species of tobacco (*Nicotiana rustica*, *N. glutinosa*, *N. tabacum*) inoculated with the corn virus failed to develop any symptoms of infection. Johnsongrass (*Sorghum halepense*), on the other hand, developed either mild mosaic symptoms or was symptomless.

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[1] Paper of the Journal Series, College of Agriculture and Environmental Science, Rutgers University, New Brunswick, N. J. 08903.

Table 1.--Sap transmission of a virus obtained from Silver Queen sweet corn in New Jersey

Variety	Test[1]	Percent of plants infected
Sweet corn:		
Stowell Evergreen------------	81/86	94.2
Golden Cross Bantam----------	71/76	93.4
NJ-106-----------------------	50/52	96.1
NJ-209A----------------------	47/47	100.0
NJ-317-----------------------	42/44	95.5
Country Gentleman------------	38/39	97.4
Midway-----------------------	28/28	100.0
Sorghum:		
Piper sudangrass-------------	62/109	56.9
DeKalb Hybrid grain sorghum--	48/63	76.2
Black Amber forage sorghum---	23/37	62.2
Ryer-15 grain sorghum--------	13/29	44.9

[1] Numerator indicates the number of plants infected; denominator the number of plants in the test.

Table 2.--Plant varieties which showed negative reactions when inoculated mechanically with the New Jersey sweet corn virus

Variety	Test[1]
Cereals:	
Redcoat wheat	0/62
Monon wheat	0/60
Lucas wheat	0/60
Pennoll wheat	0/62
Little Club wheat	0/37
Wong barley	0/65
Tschermak barley	0/53
Norline oats	0/69
Cucurbits:	
Marketer cucumber	0/24
Ashley cucumber	0/30
Early Prolific Straightneck squash	0/24
Caserta squash	0/32
Iroquois muskmelon	0/23
Charleston Gray watermelon	0/17
Soybeans:	
Harosoy 63	0/49
Hawkeye	0/42
Adelphia	0/45
Clark 63	0/30
Bethel	0/54
Lindarin	0/46

Table 2.--Continued

Variety	Test[1]
Miscellaneous:	
Scotia bean	0/32
Blackeye cowpea	0/24
Asgrow 60 pea	0/12
California Wonder pepper	0/21
Chenopodium amaranticolor	0/24

[1] Numerator indicates the number of plants infected; denominator the number of plants in test.

IDENTITY BASED ON HOST RANGE

Several mechanically transmissible viruses are known to produce mosaic symptoms in sweet corn (2). Among these are wheat streak mosaic virus (WSMV), barley stripe mosaic virus (BSMV), cucumber mosaic virus (CMV), maize dwarf mosaic virus (MDMV), and the so-called Iowa soybean mosaic virus. According to the literature, maize dwarf mosaic virus is serologically related to sugarcane mosaic virus (SCMV), the latter being known to be highly infectious to sorghum and corn (2).

Wheat streak mosaic virus is known to produce mosaic symptoms in cereals and sweet corn but not in sorghums. Since the New Jersey corn virus did infect sorghum and corn (table 1) but not cereals (table 2), its identity as WSMV is precluded. Lack of infection in cereals also indicates that the candidate virus probably is not the highly infectious barley stripe mosaic virus. Cucumber mosaic virus is infectious to cucurbits and also produces local lesions in blackeye cowpea and watermelon. Since none of these hosts were infected (table 2), the indications are that the New Jersey corn virus probably is not CMV. Lack of infection in the six soybean varieties (table 2) further suggests that the virus probably is not soybean mosaic virus. Based on symptomatology, transmission characteristics, differential plant reactions, and physical properties the New Jersey sweet corn virus is identified as maize dwarf mosaic virus described from Ohio (1, 3). Further studies on geographic distribution, host range, variation in symptoms, and serological relationships are under way.

VARIETAL REACTIONS

A group of 50 dent inbred lines of widely varying germ plasm was sent to the maize dwarf mosaic observation nursery near Portsmouth, Ohio. Of these, only three lines were resistant to the disease. J62-318 is an S_4 selection out of a single cross (W22 x CNMH501). The latter is a line from Mexico contributed by the Rockefeller Foundation in 1958. J62-392 is an S_3 selection out of a southern Corn Belt synthetic contributed in 1960 by Karl H. Jarvis of the Pioneer Corn Co. JSA52-2 is an S_5 selection from material furnished in 1957 by Clifford C. Wernham of Pennsylvania State University, who obtained it while in South Africa.

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NEW YORK

GREENHOUSE AND FIELD OBSERVATIONS FOR MAIZE DWARF MOSAIC

C. W. Boothroyd and M. L. Risius[1]

A limited survey made for maize dwarf mosaic in several counties of New York State, and greenhouse inoculations with leaf material from stunted and/or mottled plants collected within a 20-mile radius of Ithaca, did not reveal the presence of this disease in New York in 1965. Mechanical inoculations of corn (Stowell Evergreen), soybean (Harosoy 63), sudangrass (Piper), summer squash (Early Yellow Prolific Straightneck), and wheat (Lucas, Monon, and Redcoat) were initiated in August and conducted at bimonthly intervals until October.

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[1] Professor and Associate Head, Department of Plant Pathology, Cornell University, Ithaca, N. Y. 14850, and Associate Professor, Department of Agronomy, The Pennsylvania State University, University Park, Pa. 16802, respectively.

Cooperative arrangements were made with Dr. A. J. Ullstrup in Indiana to inoculate 44 inbreds and 22 hybrids in the greenhouse during the winter. Three inbreds and one hybrid proved highly resistant. Sixty-six inbreds and hybrids, from comparable seed lots, were planted at Portsmouth, Ohio, by Drs. W. R. Finley and L. E. Williams, and examined in July for MDM symptoms. Of this material only two hybrids looked good in the field. Most of the lines susceptible in the greenhouse were also susceptible in the field, and the few lines that exhibited resistance in the greenhouse were susceptible when tested in the field.

NORTH CAROLINA

CORN VIRUSES IN NORTH CAROLINA IN 1965

T. T. Hebert[1]

A limited survey was made to determine the prevalence of maize dwarf mosaic and corn stunt in North Carolina. The maize dwarf mosaic virus was found in johnsongrass in two counties and identified by symptom expression when mechanically transmitted to corn, johnsongrass, and sorghum; by electron microscopy; and by serology. Corn in fields adjacent to infected johnsongrass failed to develop symptoms typical of maize dwarf mosaic. Several attempts to transmit a virus mechanically from corn in these fields were negative. The failure of the virus to spread to the corn was attributed to the lack of activity of aphid vectors.

Stunted corn with red leaves but showing no definite mosaic pattern was found in 13 counties. While a few fields were severely affected, losses on a statewide basis were light. All attempts to transmit a virus mechanically from such corn were negative. Samples were sent to Eugene Rosenkranz at Mississippi and to Karl Maramorosch at Boyce Thompson Institute for leafhopper transmission tests. Both of these investigators indicated that they had transmitted a virus, presumably corn stunt, from the samples. Rosenkranz also tested the samples for mechanically transmissible viruses, but no viruses were detected in the samples by this means. It was concluded that both maize dwarf mosaic and corn stunt viruses occur in North Carolina and that in 1965 corn stunt was the predominant virus problem.

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DISTRIBUTION AND SEVERITY OF CORN VIRUSES IN OHIO IN 1965

Lansing E. Williams, Oren W. Spilker, and C. Wayne Ellett[1]

Maize dwarf mosaic (MDM) was first noted in a few corn plants in one or two fields along the Ohio River in 1962. At that time the cause was undetermined and its significance not realized until the next year when the disease appeared in 10,000 to 15,000 acres in 12 counties along the Ohio and Scioto Rivers. Losses in yield were estimated from a trace to 90 percent (2). Further spread of MDM was indicated the following year (1964), and loss in Ohio was estimated to be 5 million bushels. Losses varied by counties from a trace to 30 percent of harvest and were again most severe in southern Ohio along rivers and their tributaries (1, 3, 4).

Another virus, in addition to the MDM virus, was found in Ohio corn (5). This virus (called 3A temporarily) was first isolated from red-streaked corn kernels from northwestern Ohio in 1964. The 3A virus was found also to be pathogenic on small grains (oats, wheat, and barley) and was mechanically transmitted from wheat in several fields in the spring of 1965. It is now known that the 3A virus is a strain of the wheat streak mosaic virus (WSMV) (6).

DETECTION OF CORN VIRUSES

The survey for the location and severity of corn virus diseases in Ohio was sponsored jointly by the Ohio Department of Agriculture and the Ohio Agricultural Research and Development Center. The survey was initiated in June and terminated in September. Suspected virus-infected plants were assayed to seedling corn (*Zea mays* L.) Ohio W49 yellow dent and seedling wheat (*Triticum aestivum* L.) Lucas variety in the greenhouse. At the time of inoculation, corn was at the 3- to 4-leaf stage and wheat at the 2- to 3-leaf stage. Inoculations were made by the conventional carborundum leaf rub method. Symptoms of MDMV usually appeared in corn seedlings in 3 to 5 days after inoculation, and this virus did *not* infect wheat. In contrast, corn seedlings inoculated with 3A virus took 11 to 21 days to develop symptoms and wheat *was* susceptible to the virus and developed symptoms in 5 to 7 days.

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[1] Respectively, Professor, Department of Botany and Plant Pathology, Ohio Agricultural Research and Development Center, Wooster, Ohio; Plant Pathologist, Ohio Department of Agriculture, Reynoldsburg, Ohio; Associate Professor, Department of Botany and Plant Pathology, Ohio State University, Columbus, Ohio 43210.

The MDM virus was found in 38 counties and the 3A virus in 44 counties. Corn yield losses due to MDMV were estimated at 2,600,000 bushels and 900,000 bushels for the 3A virus.

DISCUSSION

Maize dwarf mosaic was most severe again in southern Ohio along rivers and their tributaries and in close proximity to johnsongrass. In some areas the disease appeared to have increased and in others decreased, as compared to previous years. Disease increases appeared to be predominantly in the "outer edges" of the severely affected areas of 1964. These increases could be explained on the basis of a buildup of the virus in johnsongrass in 1964 and a consequently plentiful supply of virus for transmission to corn early in 1965. The diminution of MDM in specific areas has been attributed to the planting of more resistant corn hybrids. It is generally believed that MDM will not become serious in the entire State of Ohio but will continue to cause significant losses in the southern one-third to one-half of the State. Some spread northward is expected to continue, particularly along stream and river valleys where johnsongrass is present. The few cases of MDM found in northern Ohio (4 counties) were not severe, and in two of these, occurred late in the season.

Considerable work needs to be done before the full effects of the 3A virus (WSMV) on corn production can be ascertained. The determination of its damage to small grains has, as yet, not been attempted.

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OKLAHOMA

[Letter report][1]

H. C. Young, Jr.[2]

"I can report corn viruses for 1965 by symptom only. We found what appeared to be corn stunt in one plant near Bixby, Oklahoma, in June. No attempt was made to transmit or otherwise recover the virus from this plant.

"In the same area the maize dwarf mosaic virus was found abundantly in sweet corn, and particularly where Johnson grass was prevalent as a weed or in fence rows. The Johnson grass itself showed symptoms in most cases. The disease occurred in a variety trial of sweet corn on the Bixby Substation and notes were recorded on disease severity." The reaction of these varieties to MDMV is given in table 1.

"No systematic search for symptoms was made in any other areas of the state." (1965)

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[1] Excerpts from letter.

[2] Professor, Department of Botany and Plant Pathology, Oklahoma State University, Stillwater, Okla. 74075.

Table 1.--The reaction of certain varieties and selections of sweet corn to the maize dwarf mosaic virus at Bixby, Okla., June 10, 1965

Variety or selection	Reaction[1]	Variety or selection	Reaction
Bonita	7	SRS 33-66	9
Aristogold Bantam Evergreen	7	SRS 33.73	[2] 3
Calumet	5	SRS 15.41	[2]
Valley Gold	3	SRS E4D5	4
Silver Queen	3	SRS E4D2	6
Seneca Brave	8	SRS Cross	2
Golden Security	4	Seneca MK 18	6
Snow Drift	1	Seneca MD 100	[2] 3
Titan	7	Seneca MK 125	4
Jubilee	7	R 2427	7
Early Triumph	5	R 3062	8
XP 223	2	R 12796	4
XP 215	9	E 3110	[2] 2
XP 205	1	E 3102	7
XP 4824	[2] 2	M 6056	4
XP 1272	[2] 2	M 4206-3 X K-A-B	2
XP 5299	6	M 4206-3 X H-3-B	3
XP 5311	[2] 5	26E61	4
NK 1304	6	380-374	6
WQ6A X H-3-B	[2] 2	382-375	1

[1] Reaction based upon a numerical scale from 1 to 9, where 1 to 3 = Mild, 4 to 6 = Moderate, and 7 to 9 = Severe.

[2] Segregating, or showing some segregates from the given reaction.

PENNSYLVANIA

[Letter report][1]

C. C. Wernham and D. R. MacKenzie[2]

"Pennsylvania collections of MDMV comprise two strains of virus having the same incubation period, thermal inactivation point, aging in vitro, dilution end point and initial symptoms on corn and based on two years collections, the same geographical distribution in Pennsylvania. The two strains were identified by differential host reaction. One strain tentatively identified as 'A' readily infects Johnson grass and Sudan hybrid Neb. 280S but only chlorotic streak symptoms are induced on inbred Ill. A. The second strain tentatively identified as 'B' does not infect Johnson grass or Neb. 280S but induces mosaic symptoms on Ill. A.

"R. E. Ford of Iowa State University has seriologically compared Pennsylvania collections of both strains with an Iowa isolate of MDMV. He could detect no difference between a Pennsylvania strain 'A' isolate and the homologous antigen. The strain 'B' isolates that were compared were only remotely related to the Iowa isolate."

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[1] Excerpts from letter.

[2] Professor and Research Assistant, respectively, Department of Plant Pathology, The Pennsylvania State University, University Park, Pa. 16802.

CORN VIRUS SUMMARY - SOUTH CAROLINA - 1965

Alfred Manwiller, G. C. Kingsland, and E. B. Eskew[1]

Virus symptoms were first noticed in two counties during the summer of 1963. While no complete survey was made the symptoms were observed in eight counties during 1965. In all cases johnsongrass was observed in the vicinity of diseased corn. Symptoms included stunting and discoloration but most often were manifested by severe stalk lodging, beginning about the time of tassel appearance and continuing through maturity. The zone of breakage was often discolored and had no particular odor. Attempts to isolate pathogens were negative.

One of the initially observed areas is a bottomland area owned by, and adjacent to, Clemson University. Corn has routinely yielded from 100 to 120 bushels per acre here over a period of years. During the very favorable seasons, 1963, 1964, and 1965, however, hybrids grown in replicated yield trials yielded from 45 to 90 bushels with some plots completely lodged by normal harvesttime (table 1).

1/ Associate Professor of Agronomy, Clemson University Pee Dee Experiment Station, P.O. Box 271, Florence, S.C. 29501, and Associate Professors, Department of Botany and Bacteriology and Department of Agronomy and Soils, College of Agriculture and Biological Sciences, Clemson University, Clemson, S.C. 29631, respectively.

Table 1.--Yield and standability of commercial hybrids grown in the presence and absence of virus infection, South Carolina Piedmont, 1963-65[1]

Hybrid	Yield		Standing plants	
	Virus-infected bottomland	Noninfected upland	Virus-infected bottomland	Noninfected upland
	Bu./acre	Bu./acre	Percent	Percent
Funk G732-------	86	80	72	89
Funk G730A------	88	73	67	86
Dixie 29[2]------	80	85	61	85
DeKalb 1006-----	78	75	68	87
Pfister 653W[2]--	71	80	54	85
McNair 425[2]----	73	74	59	80
Dixie 82--------	70	77	46	81
Pioneer 310-----	70	76	57	88
Asgrow 300------	69	73	63	76
McNair 304A-----	67	74	57	88
DeKalb 1004-----	69	70	58	77
Asgrow 502------	70	68	50	78
Embro 222-------	64	73	65	87
NC 270----------	59	74	52	90
SC 236----------	64	71	56	96
Coker 911[2]-----	47	74	28	84
Douthit Prolific[2]	45	59	28	68

1/ The two test areas were about 10 miles apart. The bottomland suffered considerably less drought stress than the upland. Six replications were planted early and six late each year in each area for the 3-year period, thus the data are averages of 36 replications.

2/ White grain.

A second very fertile and heavily infected area in Richland County south of Columbia has been used extensively for double cross production. In 1964 a 100-acre field was damaged so badly it was not harvested. In 1965 good production was accomplished by using the more susceptible single crosses as pollinators. Very severe, early lodging of these pollinators was clearly evident.

In 1965 a set of single crosses was grown on these two infected areas. These involved a common tester SC246C, which rates intermediate to susceptible when grown as a line. Plants were judged as healthy if an ear was carried on a standing stalk on October 1. After this date it was felt that storm damage and Diplodia contributed to additional breakage (table 2).

Table 2.--Single crosses of common parent SC246C grown under virus infection at Clemson, S.C., 1965

[A total of 60 plants in 2 replications were observed per hybrid]

SC246C crossed with --	Plants standing with an ear		SC246C crossed with --	Plants standing with an ear	
	October 1	November 1		October 1	November 1
	Number	Number		Number	Number
F5B50-1----	53	42	Mp414------	30	15
F5B202-1---	52	35	Mp420------	40	27
F5B174-1---	47	25	Mp440------	50	33
F5B48-1----	52	27	Mp460------	51	40
F55S8-2-2--	40	16	Mp462------	56	37
F2S66-4----	8	2	Mp464------	32	26
F319-1-----	34	20	Mp482------	55	42
FYS9-8-----	12	9	Mp486------	23	17
F6---------	28	14	SC117------	18	12
GTBJ28-----	59	30	SC138-2----	43	30
GTM68------	40	28	SC138-28---	50	38
GT112^2-3-784B	45	28	SC211C-----	27	14
L605-------	53	46	SC211E-----	23	14
L586-------	45	14	SC228-3----	37	31
L652-------	37	18	SC229TS----	39	28
L672-------	48	24	SC254A-----	55	48
Mp307------	45	36	SC257------	45	31
Mp317------	54	48	SC265R-----	44	36
Mp333------	25	16	SC273------	57	42
Mp412------	58	48	SC276I-----	41	13
			SC276T-----	34	18
			SC276V-----	49	27
			SC276W-----	40	19

Table 2.--Continued

SC246C crossed with --	Plants standing with an ear		SC246C crossed with --	Plants standing with an ear	
	October 1	November 1		October 1	November 1
	Number	Number		Number	Number
SC270R5---	30	20	SC338-----	13	6
SC277-----	56	45	SC342-----	44	28
SC278D----	58	52	SC343-----	46	28
SC287K----	54	39	SC346-----	54	39
SC301A----	33	21	SC347-----	52	32
SC301B----	32	24	SC350-----	34	19
SC301D----	28	21	SC353-----	48	32
SC301E----	31	21	SC354-----	31	21
SC311E----	31	22	SC357-----	46	24
SC312A----	17	13	SC359-----	54	44
SC312C----	10	5	SC361-----	26	19
SC313-----	44	18	SC362-----	47	30
SC325-----	12	10	SC369-----	35	17
SC328R----	14	13	SC370-----	49	32
SC330-----	47	22	SC371-----	36	26
SC331-----	40	23	SC372-----	45	17
SC332-----	42	32	SC375-----	40	29
SC333-----	56	52	SC376-----	55	47
SC336-----	39	25	SC377-----	39	17
SC337-----	42	27	SC386-----	39	29

A nursery was planted adjacent to the single crosses in 1965 with a total of 600 lines ranging from S_1s to longtime inbreds. Much more stunting and plant discoloration was evidenced here and the plants began to lodge earlier. SC301E was planted as a guard row on either side the full length of the field and showed no symptoms. In the single cross planting, however, when it appeared in combination with SC246C, about half the plants were affected (table 2). A few other lines such as L605, Mp412, and SC333 combined with SC246C to produce a single cross without visible symptoms.

Corn and johnsongrass leaves and leafhoppers were collected in Oconee and York Counties, from areas in which corn had manifested a previous history of viruslike symptoms. Transmission of virus from these samples, via mechanical means and via leafhopper caging on Coker 911 corn and AKS-614 sorghum, was unsuccessful.

Leafhoppers collected during May, June, and July 1965 from corn and johnsongrass were identified by Dr. Leon Hepner of Mississippi State College. The only species collected in large numbers was Macrosteles fascifrons. Four specimens from a total of approximately 100 were identified as Graminella nigrifrons.

Plans for 1966 include a survey of the State and screening of out-of-State lines that have been reported as tolerant. Isolation in infected fields has been secured for two or three synthetics currently being maintained, and it is hoped that the general level of tolerance can be increased by removing plants showing symptoms just prior to pollen shedding.

SOUTH DAKOTA

MAIZE DWARF MOSAIC VIRUS AND WHEAT STREAK MOSAIC VIRUS TRANSMISSION WITH DENT CORN[1]

C. M. Nagel[2], G. B. Orlob[3], and J. Tunac[4]

Maize Dwarf Mosaic Virus (MDMV) has not been identified as being present in South Dakota. In 1965, three susceptible indicator seed lots, namely AKS-614 sorghum, Hy X C103 dent corn, and Stowell Evergreen sweet corn, were grown in widely separated plots at six locations in the southeastern quarter of South Dakota, the principal corn-growing area. No MDMV symptoms were observed in any of these plantings.

REACTION OF SOUTH DAKOTA INBRED LINES TO MDMV

Through the cooperation of Dr. A. J. Ullstrup of the Purdue University Experiment Station and Drs. W. R. Findley and L. E. Williams of the Ohio Agricultural Experiment Station, approximately 150 early maturity inbred dent corn lines originally developed in a root and stalk rot resistance program by the senior author were tested at the above stations for field and greenhouse reaction to MDMV. Based on these trials, it appears that certain of these inbred lines possess a considerable degree of resistance to MDMV.

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[1] South Dakota Agricultural Experiment Station Journal Series No. 718.

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JOHNSONGRASS

Johnsongrass has been found growing volunteer in southeastern South Dakota. Overwintering of rhizomes was not observed, only seed reproduction. Rhizomes of johnsongrass, transferred from the field to the greenhouse and permitted to develop new shoots, did not develop symptoms of MDMV. Transmission tests likewise, were negative.

RED STRIPE VS. WSMV TRANSMISSION EXPERIMENTS WITH DENT CORN

Corn (variety Falconer) was reported as a host of the wheat streak mosaic virus (WSMV) from this laboratory in 1952 by Dr. J. T. Slykhuis, although the red striping of corn seed as reported by Dr. Lansing Williams was not observed.

In greenhouse and field experiments, WSMV has been transferred to a rather large number of inbred lines of dent corn resulting from a root rot resistance program developed by the senior author. WSMV produced typical and clear-cut foliage symptoms on corn somewhat similar to those on wheat.

Of 216 inbred dent corn lines inoculated under greenhouse conditions, 13 lines were apparently resistant or immune to WSMV. When the same resistant lines were grown under field conditions and artificially inoculated no symptoms resulted. Transmission experiments with the resistant or symptomless lines to wheat likewise resulted in no symptom development.

Corn plants inoculated with WSMV in field plots showed no consistency for the presence of kernel red-streak symptoms. Symptoms appeared in inoculated as well as uninoculated plots.

CORN VIRUS DISEASE IN TENNESSEE IN 1965[1]

L. M. Josephson[2] and J. W. Hilty[3]

A virus disease of corn was again prevalent in Tennessee in 1965. In 1964, the disease was observed in all counties where surveys were made, but it was damaging only in a few counties along the major rivers. More than 10,000 acres were damaged over the entire State, with an estimated loss of 150,000 bushels. Available information was reported in mimeograph form. Disease symptoms were observed in 1963 and probably were present also in 1962.

OCCURRENCE IN 1965

Mosaic symptoms of the virus were observed in corn at Knoxville by the middle part of June, and also at this time reports of symptoms of the disease were received from several areas in Tennessee. Extensive surveys for the disease were made throughout the season. As was observed in 1964, the disease is believed to be present to some degree in all counties in the State.

The disease occurred in damaging amounts in the following counties: Mississippi River Bottom Area - LAUDERDALE, SHELBY; Tennessee River Bottom Area - HAMILTON, HARDIN, HOUSTON, HUMPHREYS, PERRY; Cumberland River Bottom Area - DAVIDSON, STEWART, SUMNER, WILSON; Clinch River Bottom Area - HANCOCK; French Broad River Bottom Area - KNOX.

About the same amount of damage occurred in the Mississippi River bottom fields as in 1964. Less total damage occurred in Hardin and Humphreys Counties along the Tennessee River due to fewer acres of corn and also more tolerant hybrids being grown. The disease was not reported in Hamilton County in 1964, but in 1965 approximately 100 acres were almost completely damaged. More fields were found damaged in Davidson, Wilson, and Sumner Counties along the Cumberland River than in 1964, and this was also true in Hancock County along the Clinch River. About the same number of acres was damaged in Knox County but less total damage occurred, due mainly to more tolerant hybrids being grown.

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[1] Cooperative investigations between the Tennessee Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

[2] Professor, Department of Agronomy, University of Tennessee and Research Agronomist, Agricultural Research Service, U.S. Department of Agriculture.

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Individual fields were damaged in the following counties: BENTON, CAMPBELL, CANNON, DEKALB, DICKSON, FAYETTE, MADISON, ROBERTSON, RUTHERFORD, SEQUATCHIE, SULLIVAN, TIPTON, and WILLIAMSON.

Most of these fields were not near water and were planted with hybrids known to be very susceptible.

Over the entire State, approximately 12,000 acres were damaged, with an estimated loss of 100,000 bushels.

SYMPTOMS OF THE DISEASE

Typical symptoms of maize dwarf mosaic virus were observed in corn seedlings as early as 4 weeks after planting. These symptoms appeared as a mottle or mosaic of light and dark green on the youngest leaves. Leaves of susceptible plants soon developed a yellowish-green cast. Infected plants were readily observed 5 weeks after planting. The typical symptoms of shortening of the upper internodes, irregular areas of reddish-purple color in the leaves, and poor pollen and ear formation developed at successively later stages.

HOST PLANTS AND TRANSMISSION STUDIES

Dormant johnsongrass rhizomes were obtained in the spring from several Tennessee counties that had diseased corn in 1964. Newly emerging foliage had symptoms of the virus disease. The factor causing the symptoms was mechanically transmitted in the greenhouse to susceptible corn and sudangrass seedlings. Later, in the field, symptoms were observed on johnsongrass, field and sweet corn, sudangrass, sorghum, crabgrass, and foxtail grass. In the greenhouse, a carborundum abrasion method was used to make successful transmissions from diseased plants to several varieties of field and sweet corn, popcorn, sudangrass, sorghum, sudan-sorghum hybrids, and johnsongrass. Transmissions to tomato, squash, wheat, soybean, rye grasses, timothy, and a type of millet were unsuccessful.

Insect collections were made at various times in several locations, and we observed none resembling Dalbulus. Aphids, however, were readily found on corn at the time of early symptom appearance. Aphid populations on corn were made up primarily of the corn leaf aphid.

As in 1964, johnsongrass was abundant in fields where the disease was prevalent.

Seed collected from diseased corn plants in 1964 was planted in the greenhouse and in the Florida winter nursery. No symptoms developed, which indicates that the virus is not transmitted through the seed.

The evidence available in Tennessee, based on early appearance of symptoms, type of tranmission, and host range, indicates that the causal agent is maize dwarf mosaic virus. Because transmission tests with Dalbulus have not been made it is not known whether corn stunt virus also occurs.

REACTION OF CORN STRAINS TO THE DISEASE

Inbreds, single crosses, double crosses, varieties and synthetics, and plant introductions were tested for reaction to virus in four locations in Tennessee. Two replications of all entries were planted on two different dates at Knoxville, near Waverly in Humphreys County, and near Memphis in Shelby County, while two replications of the single crosses and double crosses were planted near Savannah in Hardin County.

Ten plants were grown in each replication of the inbreds and single crosses, while 20 plants were grown in each replication of all other entries.

Notes on infection were made periodically during the season but final ratings were made on fully grown plants. Individual plants were evaluated on the basis of the following severity grades: 0, no apparent symptoms; 1, top two or three leaves with mottling, no stunting; 2, plant above the ear mottled and discolored, none or very little stunting; 3, plant above the ear discolored and stunted, ear reduced in size; 4, entire plant discolored and stunted, small or no ear produced; 5, plant completely collapsed, no ear.

A severity index for each entry was determined by multiplying the number of plants in each grade by the grade value, and the sum of these products was divided by the total number of plants.

Means for all replications and planting dates for each location were calculated. Entries with a severity index of 1.00 or less probably were not reduced in yield, while those above 3.00 would have less than 50 percent yield. Entries with a high percentage of the plants diseased and with a low severity index must be considered to have a degree of tolerance. This is especially true if mosaic symptoms were detected early. Entries indicating resistance or tolerance should be tested further. However, those entries with a high percentage of plants diseased and with a high severity index, must be considered as susceptible to the virus involved and should be eliminated from use in a production program.

Variations due to low incidence of disease occurred in some locations, and they were also due to the necessity of more than one individual evaluating the severity grades in a particular test. No two individuals make the same comparative ratings where differences in degree are involved. Also, in making ratings of some entries, particularly inbreds, there was a possibility of confusing normal pale streaking in the top leaves with mosaic symptoms.

Data obtained on the reaction of inbreds and hybrids have been distributed in mimeographed reports, which are available upon request. The following inbreds had no symptoms of virus: CI. 45, Ga209, Va35C, and Je38.Teko Y. Inbreds T109, T111, T115, H.751(W), T8, T202, T212, T222, T230, Ramsey IV, T61.984, E663, E683, Mp111, Mp113, Mp462, SC155, Ky122, and Ite 701 indicated a high degree of tolerance. Most single crosses with T115 had a high degree of tolerance. Several double crosses also indicated tolerance to the virus.

Incidence of disease was too low to make the data on the varieties and synthetics very meaningful. The same was true for the introductions tested. However, sufficient disease occurred to indicate that 68 of the 199 tested are susceptible.

Seventy-one S_1 selections from the variety Jellicorse were grown in a replicated yield trial at Knoxville. A high incidence of disease occurred in this test. The distribution of these selections grouped by severity index classes were as follows:

Average severity index:	Number of selections
0	0
0 - 0.99	15
1.00 - 1.99	34
2.00 - 2.99	18
3.00 - 3.99	4
4.00 - 4.99	0

INHERITANCE OF RESISTANCE

The inheritance pattern of resistance or tolerance to the virus was studied in seven crosses between susceptible and resistant or tolerant inbreds in three locations in Tennessee. The two parents, the F_1 and F_2 generations, and one and two backcrosses to each parent were studied in the different crosses. Individual plants were rated by severity grade as was done in the resistance tests. The data for each entry are shown in table 1.

Table 1.--Percentage plants diseased and severity index for inbreds, F_1, F_2, and backcross generations grown in three locations in Tennessee in 1965

Hybrid and generation	Knox County - Knoxville			Humphreys County - Waverly			Shelby County - Memphis		
	Total plants	Plants diseased	Severity index	Total plants	Plants diseased	Severity index	Total plants	Plants diseased	Severity index
	Number	Percent		Number	Percent		Number	Percent	
T101(Susc.)-------	29	87	3.5	50	35	0.9	20	66	2.7
T115(Res.)--------	35	57	.8	60	22	.3	26	40	.5
(T101xT115)F_1-----	37	18	.3	63	6	.1	38	27	.6
(T101xT115)F_2-----	31	65	1.7	68	45	1.0	35	43	1.2
(T101xT115)xT101--	39	47	1.3	49	38	.8	34	38	1.4
(T101xT115)xT101xT101	34	65	2.2	59	44	1.4	34	52	1.8
(T101xT115)xT115--	39	61	1.1	67	21	.3	36	37	.8
(T101xT115)xT115xT115	35	49	.7	66	17	.2	25	29	.7
T105(Susc.)-------	37	91	2.7	51	100	4.3	22	100	4.6
T115(Res.)--------	42	47	.8	63	18	.2	24	26	.5
(T105xT115)F_1-----	36	39	.8	76	19	.3	34	56	1.5
(T105xT115)F_2-----	36	66	1.6	68	63	1.7	25	66	2.6
(T105xT115)xT105--	35	81	2.4	65	86	2.7	33	76	2.6
(T105xT115)xT105xT105	31	94	3.5	60	88	3.4	15	70	3.1
(T105xT115)xT115--	33	49	.8	68	20	.4	37	44	1.2
(T105xT115)xT115xT115	37	49	.6	67	20	.3	30	38	.9
T218(Susc.)-------	32	94	2.6	55	98	3.6	19	100	3.5
T220(Res.)--------	29	44	1.3	55	59	1.3	26	19	.6
(T218xT220)F_1-----	40	10	.2	64	14	.2	31	25	.6
(T218xT220)F_2-----	38	45	1.0	70	63	1.6	35	72	2.3
(T218xT220)xT218	35	51	1.2	71	73	2.0	25	71	2.2
(T218xT220)xT220	36	17	.3	58	24	.5	35	41	1.2

Table 1.--Continued

Hybrid and generation	Knox County - Knoxville			Humphreys County - Waverly			Shelby County - Memphis		
	Total plants	Plants diseased	Severity index	Total plants	Plants diseased	Severity index	Total plants	Plants diseased	Severity index
	Number	Percent		Number	Percent		Number	Percent	
T218(Susc.)-------	33	91	2.5	68	97	3.0	19	85	3.0
T222(Res.)--------	25	65	2.0	40	54	1.4	26	7	.2
(T218xT222)F_1-----	38	39	1.3	61	54	1.1	37	63	1.8
(T218xT222)F_2-----	35	58	1.2	69	59	1.6	30	69	2.3
(T218xT222)xT218--	39	75	1.7	70	85	2.6	30	100	3.3
(T218xT222)xT222--	35	39	.7	70	19	.4	36	53	1.6
T218(Susc.)-------	28	100	3.1	55	100	3.5	12	100	3.7
T224(Res.)--------	28	28	.5	56	32	.6	19	11	.3
(T218xT224)F_1-----	35	32	.7	64	15	.3	37	54	1.4
(T218xT224)F_2-----	37	76	1.8	66	50	1.2	34	69	2.0
(T218xT224)xT218--	36	73	1.7	53	65	1.6	29	76	2.5
(T218xT224)xT224--	34	27	.5	60	21	.4	34	24	.6
T13(Susc.)--------	22	96	4.6	43	92	3.5	12	100	4.5
T115(Res.)--------	37	51	.6	59	27	.4	25	21	.5
(T13xT115)F_1------	38	24	.4	70	14	.3	37	41	1.1
T218(Susc.)-------	30	91	2.4	59	98	3.6	27	100	4.0
T204(Res.)--------	36	69	2.0	58	39	.8	31	33	.6
(T218xT204)F_1-----	38	51	1.2	67	90	2.2	32	61	1.6

Differences between generations were significant in all crosses. Since T101 was found to segregate for resistance and susceptibility, it was eliminated from further analysis. In nearly all crosses the severity index of the F_1 populations approached or exceeded the resistant parent. The F_2 populations were near midway between the two parents for both percentage diseased plants and severity index. With two exceptions, backcrosses to the resistant parent were as resistant as the parent. One backcross to the susceptible parent produced a severity index about equal to the F_2 while an additional backcross to the susceptible parent raised the severity index almost to that of the susceptible parent. All these facts indicate at least partial dominance of resistance.

The data were analyzed quantitatively to determine heritabilities and the number of factor pairs involved. Based on the variances of the F_2 and the two backcross generations the following heritability values were obtained:

Cross:	Knoxville	Waverly	Memphis
T105xT115 -----	0.356	0.523	0.478
T218xT220 -----	.524	.650	.120
T218xT222 -----	.450	.858	.916
T218xT224 -----	.714	.657	.456

Using Wright's correction of Castle's formula, one and two factor pairs were found involved in the different crosses. The data indicate that resistance or tolerance is dominant and controlled by one or two major genes, with perhaps some modifiers. It should not be too difficult to transfer this resistance by a backcross breeding procedure.

MAIZE DWARF MOSAIC VIRUS OCCURRENCE, DISTRIBUTION, AND DISEASE LOSS IN TEXAS[1]

R. W. Toler and C. D. Hobbs[2]

OCCURRENCE

Maize dwarf mosaic virus (MDMV) was observed causing a disease of field crops in Burleson County, Tex., May 19, 1966. Naturally infected plants of corn, grain sorghum, and johnsongrass (Jg) showing symptoms typical of MDMV were found in the same vicinity. The virus was readily transmitted mechanically in the greenhouse from the naturally infected hosts to healthy plants of AKS-614 grain sorghum, Golden Cross Bantam sweet corn, and common johnsongrass.

IDENTIFICATION

The host range of the isolates collected in Burleson County was the same as that reported by other workers [Dale (1), Shepherd (2), and Williams and Alexander (4)]. The virus was partially purified using Shepherd's procedures (2) from AKS-614 inoculated in the greenhouse with the isolate collected from naturally infected johnsongrass. The partially purified virus gave positive precipitin tests when reacted with absorbed antiserum prepared from the Arkansas isolate of MDMV supplied by J. L. Dale of the University of Arkansas. AKS-614 infected plants were used as the source of infected cells for quick-dip mounting of electron microscope grids as described by Thornberry and others (3) for MDMV. Microdroplets of expressed sap were diluted with equal parts distilled water on collodian coated grids, dried, and shadowed with chromium. The grids were observed with an Hitachi Hs7s electron microscope. Electron microscopy of the virus-infected cell contents showed the majority of the particles were flexious rods averaging 12 to 15 mμ. in width and 740 to 800 mμ. in length. Flexious rods were not observed in cell preparation from healthy sorghum plants.

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[1] Contribution of the Department of Plant Sciences, Texas A&M University, College Station, Tex. Approved as Texas Agricultural Experiment Station Technical Article No. 5653.

[2] Assistant Professor, Department of Plant Sciences, Texas A&M University, and Extension Plant Pathologist, Texas Agricultural Extension Service, respectively.

INSECT TRANSMISSION

Insect transmission with corn leaf aphids (*Rhopalosiphum maidis* (Fitch)) was of the nonpersistent type. When corn leaf aphids collected in the field on infected corn, sorghum, and johnsongrass were fed, a single aphid per healthy AKS-614 sorghum plant transmitted the virus to 4.5 percent of the healthy plants. Virus-free *R. maidis*, starved 2 hours and given a single observed probe for acquisition and placed one aphid per healthy AKS-614 plant, transmitted the virus 15 percent of the time in 55 single feedings.

GENETIC EFFECT

Reactions of corn inbred lines to natural infection were similar to that reported for the same genetic material in other areas.

The reactions of known genetic material to the MDMV found in Texas indicate that the virus has the same pathogenicity as that found in other States (table 1), and is not a new biotype or strain.

Table 1.--Reactions of corn inbred lines to maize dwarf mosaic virus under natural infection in Texas

Inbred line	Rating[1]	Diseased plants	Disease index[2]
		Percent	
H 49------	I	0.5	1.0
Va 36-----	R	.5	1.0
T 111-----	R	1.0	2.0
T 111-----	R	0	0
T 222-----	R	0	0
T 474-----	S-I	50.0	2.0
C.I. 21---	R-I	20.0	1.0
Mo 5------	S	90.0	3.0
K 55------	S	100.0	4.0
T 210-----	R-I	0	0
Tx 601----	R	0	0
Tx 403----	R-I	1.0	1.0
Tx 303----	S	33.0	3.0

[1] R, Resistant; I, intermediate; S, susceptible.

[2] 0, no symptoms; 1, 2 or 3 top leaves mottled; 2, all top leaves mottled and discolored, no observable stunting; 3, plant discolored, stunted, ear development delayed; 4, entire plant discolored, stunted, and ear absent or extremely underdeveloped; 5, plant destroyed.

SURVEY

A virus disease survey of the major corn-producing counties in Texas was conducted June 8 through 24. Fifty-four counties were surveyed as shown in figure 1. Symptoms of MDMV were observed on corn, grain sorghum, and johnsongrass; positive transmission of MDMV was achieved from 35 of the 54 counties surveyed. The symptoms were typical of those observed in other areas (4); i.e., faint to heavy mottling of the upper leaves (fig. 2). The mottling was usually an interveinal mosaic of light- and dark-green areas on corn. Infected sorghum plants had a general chlorotic appearance with the dark-green areas of mottling appearing as islands in a lighter green background. On johnsongrass the chlorotic areas appeared somewhat more spotted or blotched than on the other hosts.

Red leaf symptoms in the field appeared only on corn and then only on certain varieties very late in the growing season. Stunting was evident in all three plant species in the field. Samples of leaf material from diseased plants from each county surveyed were collected, refrigerated, and returned to the laboratory for biological assay on corn, grain sorghum, and johnsongrass.

Out of 124 samples including all types of symptoms in corn collected on the survey, 63 percent were infected with MDMV. Seven of the isolates failed to go to johnsongrass, but infected either corn or sorghum. When inoculation of these isolates was repeated on johnsongrass, all but three produced symptoms. Identification of the three isolates that failed to go to johnsongrass is pending.

DISEASE LOSS

Severity of MDMV in infected fields ranged from trace amounts to as high as 80-percent infection. Average infections of approximately 10 percent were observed in the Central and North Texas Blacklands. Infections of 1 to 5 percent occurred in Central and Southeast Texas except for a few individual fields which had higher infection rates.

The disease loss estimate based on occurrence, distribution, incidence and disease index on corn in the State in 1966 was 4.2 percent. Loss to the corn crop was valued at one million ten thousand dollars (1.01 million dollar loss).

This report established MDMV occurrence, identity, and loss on corn in Texas. In addition, the disease is a threat to the State's 5.5 million acres of grain sorghum. The impact of MDMV on this crop is still to be determined. The virus was observed attacking grain sorghum in the corn

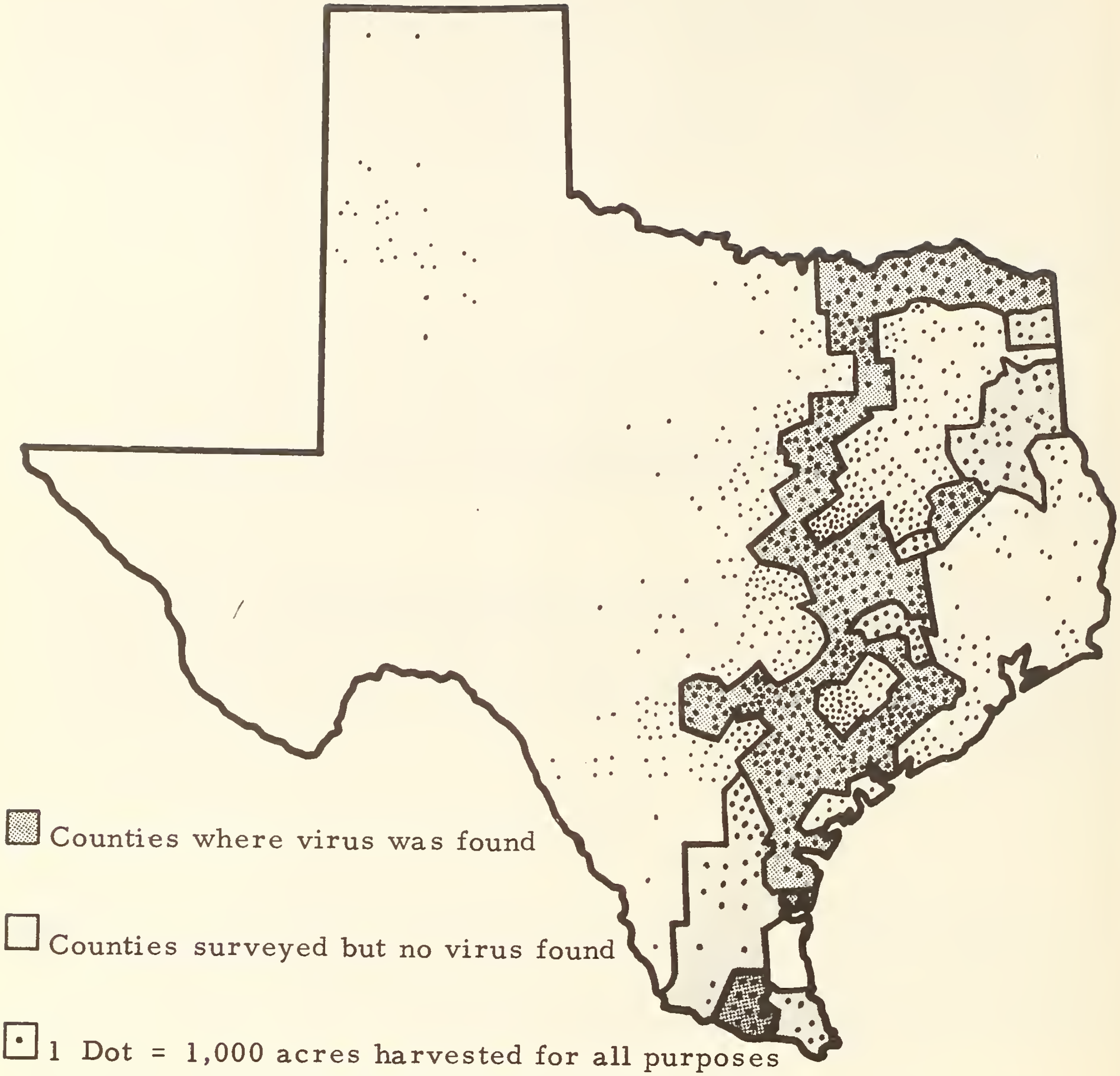
▨ Counties where virus was found
☐ Counties surveyed but no virus found
⊡ 1 Dot = 1,000 acres harvested for all purposes

FIGURE 1.--Distribution of corn acreage, areas surveyed, and presence of maize dwarf mosaic virus in Texas.

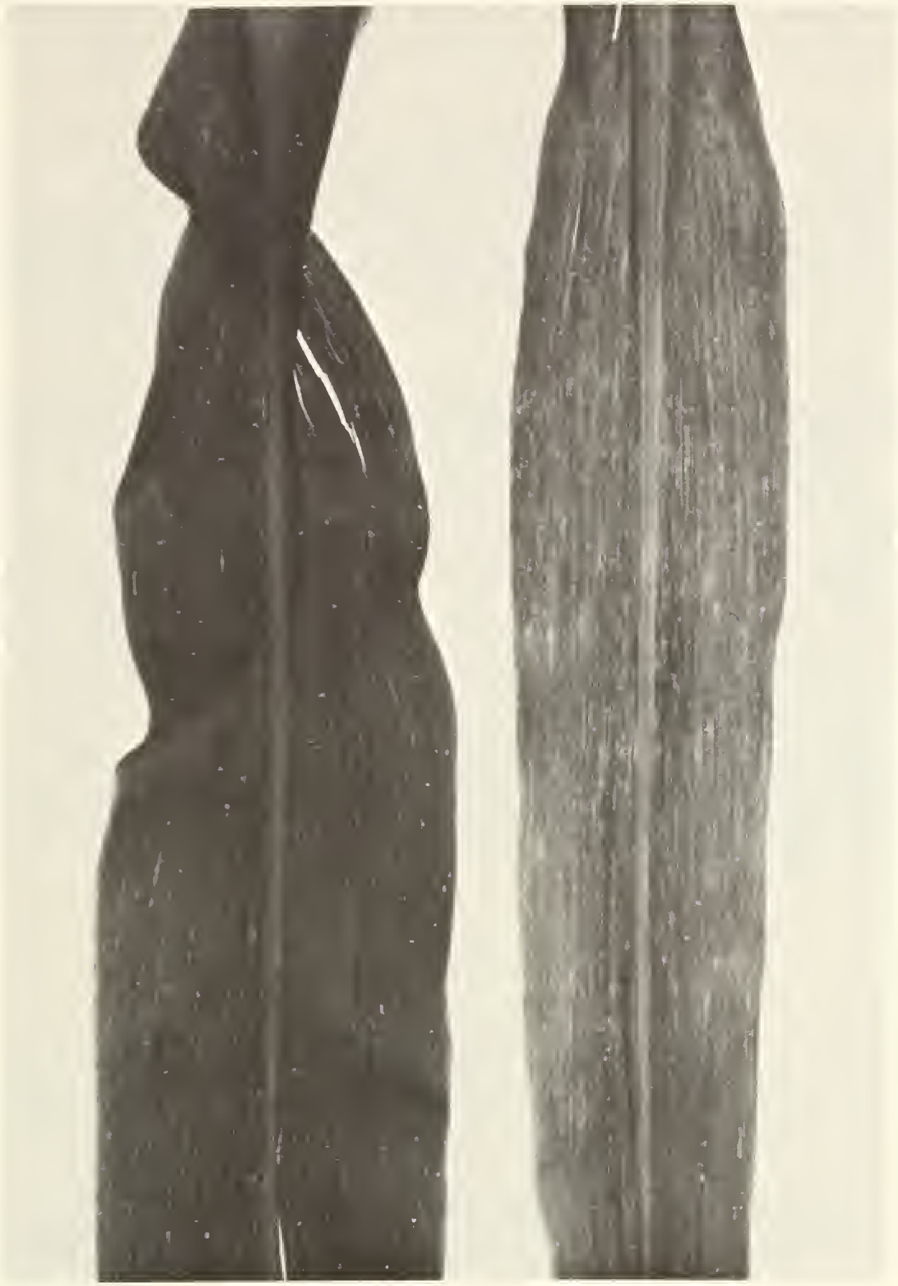

FIGURE 2.--Mottling symptoms of maize dwarf mosaic on corn. Healthy leaf left; diseased leaf right.

growing area surveyed; however, the major acreages of grain sorghum do not overlap with that of corn.

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VIRGINIA

MAIZE DWARF MOSAIC IN VIRGINIA, 1965

C. W. Roane and C. F. Genter[1]

Maize dwarf mosaic (MDM) was found on an estimated 10,000 acres of corn in 37 counties of Virginia in 1965. In many cases, damage was nil, but at two locations corn totaling 15 acres was abandoned. Severe damage occurred on 5,000 acres, most of which was in the James River Valley. (See fig. 4 in "General Summary of Corn Virus Distribution.") Wherever corn was planted near small grains and where infected johnsongrass, Sorghum halepense, was prevalent, early, severe MDM infection occurred in corn. The 1965 survey was conducted primarily by staff of the Virginia Department of Agriculture and Immigration: namely, W. H. Matheny, V. B. Harrell, D. H. Kludy, and H. S. Miller.

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On corn plants infected early, little or no grain was produced. This was attributed in part to the slow growth of silks on these plants. By the time the silks emerged, little or no pollen was available.

The virus was transferred to and recovered from the following wild grasses in addition to those reported previously (1): *Digitaria sanguinalis* (L.) Scop. - crabgrass; *Eleusine indica* (L.) Gaertn. - goosegrass; *Eragrostis cilianensis* (All.) Link - stinkgrass; *Paspalum dilatatum* Poir. - dallisgrass; *Setaria lutescens* (Weigel) F. T. Hubb - yellow bristlegrass; *Triodia flava* (L.) Smyth - purpletop.

Of the grass species that have been mechanically inoculated with MDM virus, johnsongrass, dallisgrass, and purpletop are perennial, but only johnsongrass functions as a virus source in the epiphytology of MDM. In addition to overwintering the virus, johnsongrass is a preferred host for the aphid vectors; other wild grass hosts of the virus apparently are poor hosts for the vectors. No doubt, this explains the close association of MDM with johnsongrass-infested areas.

An attempt was made to evaluate commercial hybrids and miscellaneous germ plasm for reaction to MDM. We were unable to use the site originally planned for the test and chose a second site thoroughly infested with johnsongrass which had low level of virus infection. As a result, a very low percentage of susceptible plants were infected and the data obtained were inconclusive.

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CANADA: MANITOBA

[Letter report][1]

John Giesbrecht[2]

"I am pleased to report that to date no corn virus has been detected in Manitoba." (1965)

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[1] Excerpt from letter.

[2] Research Officer Corn and Soybeans, Canada Department of Agriculture, Research Branch, Experimental Farm, Morden, Manitoba, Canada.

CORN VIRUS DISEASES IN ONTARIO IN 1965

R. E. Wall[1], Y. C. Paliwal[2], J. T. Slykhuis[3], and C. G. Mortimore[4]

INTRODUCTION

The bulk of the grain corn in Canada is produced in the southern part of Ontario, between Lakes Huron and Erie. Previous to 1965 there have been no reports of virus diseases in this crop. Wheat streak mosaic virus, an occasional pathogen of corn (2), was first detected in winter wheat in Ontario in 1964 (4) and in corn in 1965 (1).

WHEAT STREAK MOSAIC VIRUS

In August of 1965, occasional stunted, mottled plants were found in several fields in Essex and Kent Counties in southwestern Ontario. Such plants were usually found in weedy areas where growth of corn was generally poor. Nearby foxtail grass (*Setaria viridis*) and barnyard grass (*Echinochloa crusgalli*) often had mottled or streaked leaves. Sap inoculations from these weeds and from diseased corn to wheat indicated that a virus was present. Through serological tests and transmission by the mite *Aceria tulipae*, the virus was shown to be very similar, if not identical, to wheat streak mosaic virus (1).

RED-STRIPED PERICARP

Red streaking of corn grain was first observed in Essex and Kent Counties of southwestern Ontario in 1964. In 1965 it was found throughout the corn-growing region of southern Ontario. The condition first appeared in early August, when the kernels were beginning to dent, and increased in intensity and incidence until maturity. Although the amount of red-stripe varied among hybrids and lines, few varieties were free of this condition (5).

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[2] Canadian National Research Council Post Doctorate Fellow, Plant Virology Section, Cell Biology Research Institute, Canada Department of Agriculture, Ottawa, Ontario, Canada.

[3] Chief, Plant Virology Section, Cell Biology Research Institute, Canada Department of Agriculture, Ottawa, Ontario, Canada.

[4] Head of Field Crops Section, Harrow Research Station, Canada Department of Agriculture, Harrow, Ontario, Canada.

Red-stripe was found to have no effect on seed germinability (5). Seedlings from red-striped seed appeared the same as those from normal seed. Grain from plants grown from apparently normal seed had as much red-stripe as that grown from red-striped seed.

Kernels, cobs, and husks from plants with red-striped grain were macerated in pH 7.0 phosphate buffer and the sap applied to wheat and corn seedlings with an abrasive. No symptoms developed from any of the inoculation attempts.

MAIZE DWARF MOSAIC

Throughout July and August of 1965, seedlings of Stowell Evergreen and Seneca Chief sweet corn were inoculated periodically with sap from stunted or mottled plants collected from various parts of southwestern Ontario. Since no symptoms developed on inoculated plants it was concluded that the maize dwarf mosaic virus was not present in the district.

DISCUSSION

To date (1965) there have been no serious virus problems in corn in Ontario. Previous studies of wheat streak mosaic virus in the west (2, 3) would indicate that it may not be a serious threat to corn. However, the discovery of this virus in eastern regions raises speculation as to its future role in wheat production. Although corn may not be adversely affected, it could serve as a source of infection for the winter wheat crops grown in southern Ontario and adjacent regions.

Because no mechanically transmissible virus could be obtained from corn with red-striped grain, as done by Williams and others (6), it is believed that wheat streak mosaic and red-striped pericarp are unrelated phenomena.

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1955. Host range studies of the wheat streak mosaic virus. U.S. Agr. Res. Serv. Plant Dis. Rptr. 39: 633-642.

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1953. Wheat streak mosaic virus in Alberta and factors related to its spread. Canad. Jour. Agr. Sci. 33: 195-197.

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1964. Noteworthy and new records of grass viruses in Canada in 1964. Canada Dept. Agr., Canad. Plant Dis. Survey 44: 242-243.

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1965. Red-striped pericarp of corn. Canada Dept. Agr., Canad. Plant Dis. Survey 45: 92-93.

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1965. A virus isolated from red-streaked corn grain. (Abstract.) Phytopathology 55: 1083-1084.

GENERAL SUMMARY OF CORN VIRUS DISTRIBUTION INCLUDING NEGATIVE REPORTS[1]

Compiled by Warren N. Stoner[2]

Figures 1 to 3 give the general distribution of all corn viruses in the continental United States for the years 1963, 1964, and 1965. They do not necessarily indicate progressive spread or degrees of severity. The maps (figs. 1-3) are composites of reports received based on field identification of the various viruses by symptoms observed in the field, actual virus-recovery tests, and distribution according to the literature. After the first 2 years of investigation, it became clear that more than one virus was involved in the overall problem. Since symptom syndromes of the viruses were similar, the use of symptoms alone was not reliable for certain identification of particular viruses. Consequently, in 1965 virus recoveries to a suitable host range were made whenever possible to compliment the surveys. (Most of the surveys and virus recoveries were made with maize as the indicator host.) As knowledge of host ranges of the viruses increases, areas of distribution should become more clearly defined. Still, the maps (figs. 1-3) have some value in giving some idea of the distribution at the beginning of the surveys and show generally how the investigations developed until a more precise presentation was possible.

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[1] This general summary was derived from the individual reports of the cooperators, personal correspondence, and the literature. The compilations are given by counties (or parishes) alphabetically arranged under each virus. The listing includes only counties where actual virus recoveries were obtained from field-collected diseased plants.

[2] Entomologist, Entomology Research Division, ARS, U.S. Department of Agriculture, Northern Grain Insects Research Laboratory, Brookings, S. Dak. 57006.

Figures 4 to 6 show the counties where different corn viruses have been isolated from diseased field plants. These maps show the known distribution of the respective viruses. Even though virus-recovery data are somewhat limited, it is evident that the ranges of the viruses overlap. Further investigations should more closely define the areas of occurrence of particular corn viruses. Until such information becomes available the question of whether or not these viruses are spreading will remain relatively imponderable.

The following lists of the States and counties where various corn virus diseases occur are given for convenient reference and to supplement the maps of figures 4 to 6.

Maize Dwarf Mosaic

ARKANSAS: Baxter, Carroll, Conway, Crawford, Faulkner, Franklin, Grant, Hempstead, Hot Spring, Howard, Independence, Johnson, Lawrence, Little River, Marion, Mississippi, Pike, Pope, Pulaski, Randolph, St. Francis, Scott, Sharp, Stone, Van Buren, Washington, Yell.

ILLINOIS: Alexander, Calhoun, Clark, Crawford, Hardin, Jackson, Jersey, Johnson, Massac, Monroe, Pope, Randolph, Scott, Union.

INDIANA: Clark, Crawford, Dearborn, Floyd, Harrison, Jefferson, Ohio, Perry, Shelby, Spencer, Sullivan, Switzerland, Tippecanoe.

IOWA: Fremont.

KANSAS: Leavenworth.

KENTUCKY: Adair, Allen, Ballard, Barren, Bath, Bracken, Breckinridge, Bullitt, Campbell, Carlisle, Carroll, Casey, Clark, Crittenden, Cumberland, Estill, Fayette, Fleming, Franklin, Gallatin, Greenup, Hancock, Hart, Henry, Jefferson, Kenton, Lewis, Madison, Marion, Mason, Monroe, Nelson, Robertson, Trimble, Warren.

LOUISIANA: Madison, Ouachita, Rapides, Union.[3]

MARYLAND: Allegany.

MISSISSIPPI: Oktibbeha, Yazoo.

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[3] The virus recovered may be SCMV.

NEW JERSEY: Burlington.

NORTH CAROLINA: Mecklenburg, Rowan.

OHIO: Adams, Ashtabula, Athens, Belmont, Brown, Butler, Clermont, Clinton, Fairfield, Franklin, Gallia, Greene, Guernsey, Hamilton, Hancock, Highland, Hocking, Jackson, Lawrence, Madison, Meigs, Miami, Monroe, Montgomery, Morgan, Muskingum, Noble, Pickaway, Pike, Preble, Ross, Sandusky, Scioto, Shelby, Summit, Vinton, Warren, Washington.

PENNSYLVANIA: Adams, Bedford, Blair, Butler, Centre, Clinton, Crawford, Dauphin, Erie, Fayette, Franklin, Fulton, Juniata, Lancaster, Lebanon, Lycoming, Mifflin, Northumberland, Perry, Somerset, Wyoming.

TENNESSEE: Humphreys, Knox, Shelby, Stewart, Trousdale.

VIRGINIA: Amherst, Appomattox, Bedford, Botetourt, Charlotte, Halifax, Henry, Lee, Montgomery, Pittsylvania, Roanoke, Scott.

Corn Stunt

FLORIDA: Dade.

MISSISSIPPI: Covington, Hinds, Monroe, Oktibbeha, Yazoo.

NORTH CAROLINA: Davie, Iredell, Jones, Union.

3A Virus

OHIO: Allen, Auglaize, Butler, Champaign, Clark, Clinton, Columbiana, Crawford, Defiance, Erie, Fayette, Franklin, Fulton, Greene, Guernsey, Hamilton, Hancock, Hardin, Henry, Highland, Huron, Knox, Logan, Lorain, Lucas, Marion, Mercer, Miami, Montgomery, Ottawa, Paulding, Pickaway, Preble, Putnam, Sandusky, Seneca, Shelby, Stark, Summit, Warren, Wayne, Williams, Wood, Wyandot.

Wheat Streak Mosaic

IDAHO: Ada, Gem, Lemhi, Nez Perce, Payette.

KANSAS: Saline.

NEBRASKA: Hall, Johnson, Phelps.

WASHINGTON: Whitman.

CALIFORNIA: Butte, Contra Costa, Fresno, Kern, Kings, Los Angeles, Madera, Merced, Orange, Sacramento, San Joaquin, Stanislaus, Tehama, Tulare, Yolo.

LOUISIANA: Madison, Ouachita, Rapides, Union.

Letter reports from the persons listed indicated virus diseases of corn were not seen in the following States nor in Canada in 1965.

ARIZONA: Reported by M. R. Nelson, Associate Professor, Virus Diseases, Department of Plant Pathology, University of Arizona, Tucson, Ariz. 85721.

CANADA - MANITOBA: Reported by John Giesbrecht, Research Officer Corn and Soybeans, Canada Department of Agriculture, Research Branch, Experimental Farm, Morden, Manitoba.

COLORADO: Reported by L. E. Dickens, Extension Plant Pathologist, Cooperative Extension Service, Colorado State University, Fort Collins, Colo. 80521.

CONNECTICUT: Reported by Saul Rich, Plant Pathologist, Connecticut Agricultural Experiment Station, 123 Huntington Street, Box 1106, New Haven, Conn. 06504.

DELAWARE: Reported by H. W. Crittenden, Associate Professor, Soybean Diseases (Breeding), Department of Plant Pathology, University of Delaware, Newark, Del. 19711.

IDAHO: Reported by W. R. Simpson, Associate Plant Pathologist, Vegetable Diseases, Department of Plant Sciences, University of Idaho, Branch Experiment Station, Parma, Idaho 83660.

MAINE: Reported by R. C. McCrum, Associate Professor of Plant Pathology, Department of Botany and Plant Pathology, University of Maine, Orono, Maine 04473.

MASSACHUSETTS: Reported by C. J. Gilgut, Professor of Plant Pathology, Department of Entomology and Plant Pathology, University of Massachusetts, Amherst, Mass. 01003.

MINNESOTA: Reported by T. H. Kommedahl, Professor of Cereal Diseases and Soil Borne Pathogens, Department of Plant Pathology and Physiology, University of Minnesota, St. Paul, Minn. 55101.

MONTANA: Reported by E. R. Hehn, Professor and Head of Department of Plant and Soil Science, Montana State University, Bozeman, Mont. 59715.

NEBRASKA: Reported by D. S. Wysong, Extension Plant Pathologist, Department of Plant Pathology, University of Nebraska, Lincoln, Neb. 68503.

NEVADA: Reported by S. D. Lyda, Assistant Plant Pathologist, Plant Soil and Water Division, University of Nevada, Reno, Nev. 89507.

NEW HAMPSHIRE: Reported by A. E. Rich, Professor of Plant Pathology, Department of Botany, University of New Hampshire, Durham, N. H. 03824.

NEW MEXICO: Reported by Ervin Williams, Jr., Assistant Professor, Department of Agricultural Services, New Mexico State University, University Park, N. Mex. 88070.

NORTH DAKOTA: Reported by R. G. Timian, Research Plant Pathologist, U.S. Department of Agriculture, Agricultural Research Service, Crops Research Division, North Dakota State University, Department of Plant Pathology, Fargo, N. Dak. 58103.

OREGON: Reported by R. L. Powelson, Associate Plant Pathologist, Department of Botany and Plant Pathology, Oregon State University, Corvallis, Oreg. 97331.

UTAH: Reported by O. S. Cannon, Professor and Head of Department, Department of Botany, Utah State University of Agriculture and Applied Science, Logan, Utah 84321.

WASHINGTON: Reported by G. W. Bruehl, Professor and Plant Pathologist, Department of Plant Pathology, Washington State University, Pullman, Wash. 99163.

WISCONSIN: Reported by D. C. Arny, Professor, Department of Plant Pathology, University of Wisconsin, Madison, Wis. 53706.

WYOMING: Reported by Charles W. McAnelly, Associate Plant Pathologist and Horticulturist, Department of Plant Pathology and Horticulture, University of Wyoming, University Station, P.O. Box 3354, Laramie, Wyo. 82071.

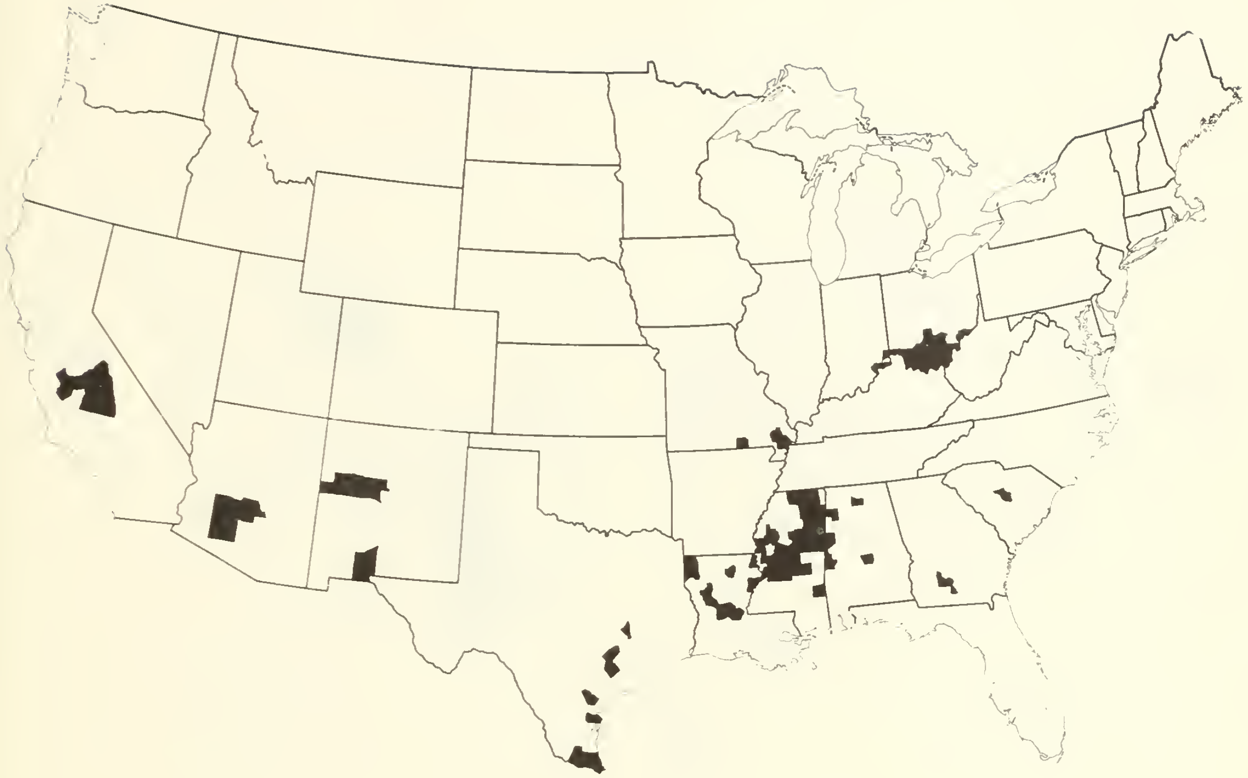

FIGURE 1.--Distribution of known or suspected corn stunt virus infection in 1963. This distribution was derived primarily from surveys based on observations of symptoms and literature based on observations of symptoms.

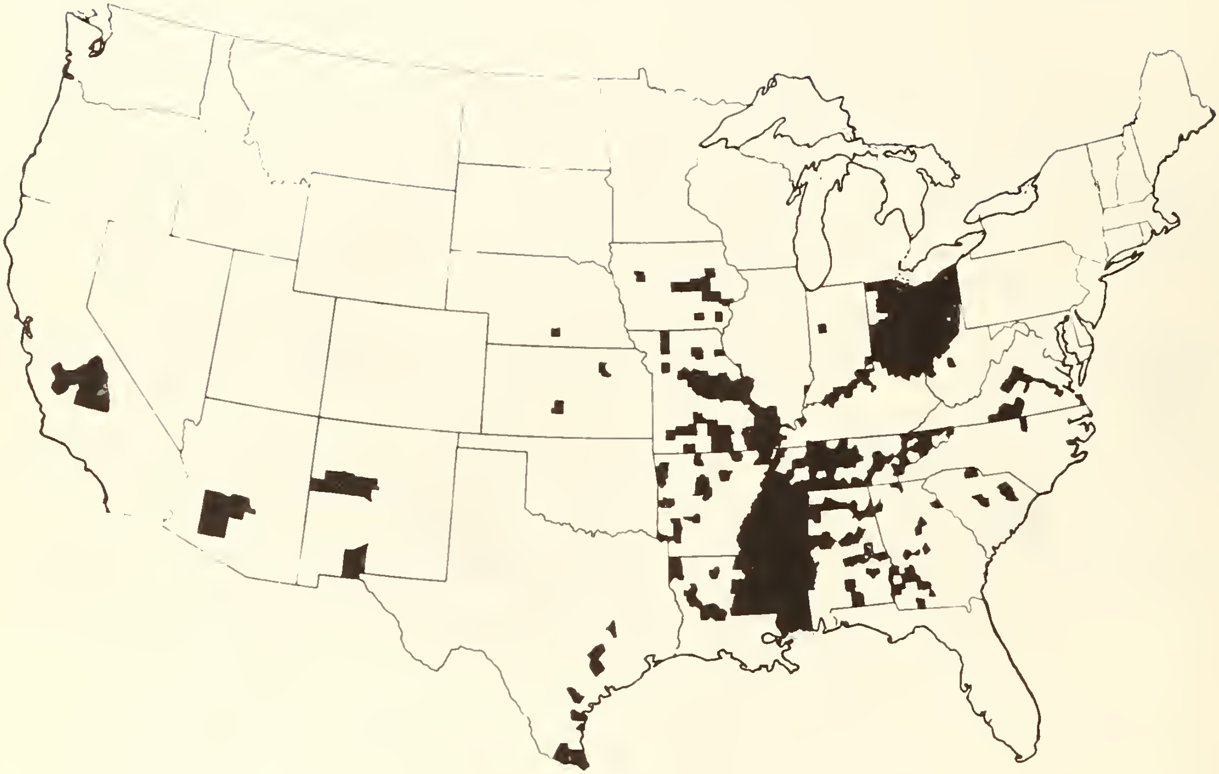

FIGURE 2.--Counties where corn virus infections were known or suspected in 1964. It was becoming evident that a virus "complex" was involved. CSV and SCMV were known. Another virus, later characterized and named "maize dwarf mosaic virus" (MDMV), was determined midway in the season. A fourth unknown virus (3A virus) was suspected late in the season. This figure was derived not only from surveys and literature citations based on observations of symptoms but also on limited virus-recovery trials and confirmed reports in the literature.

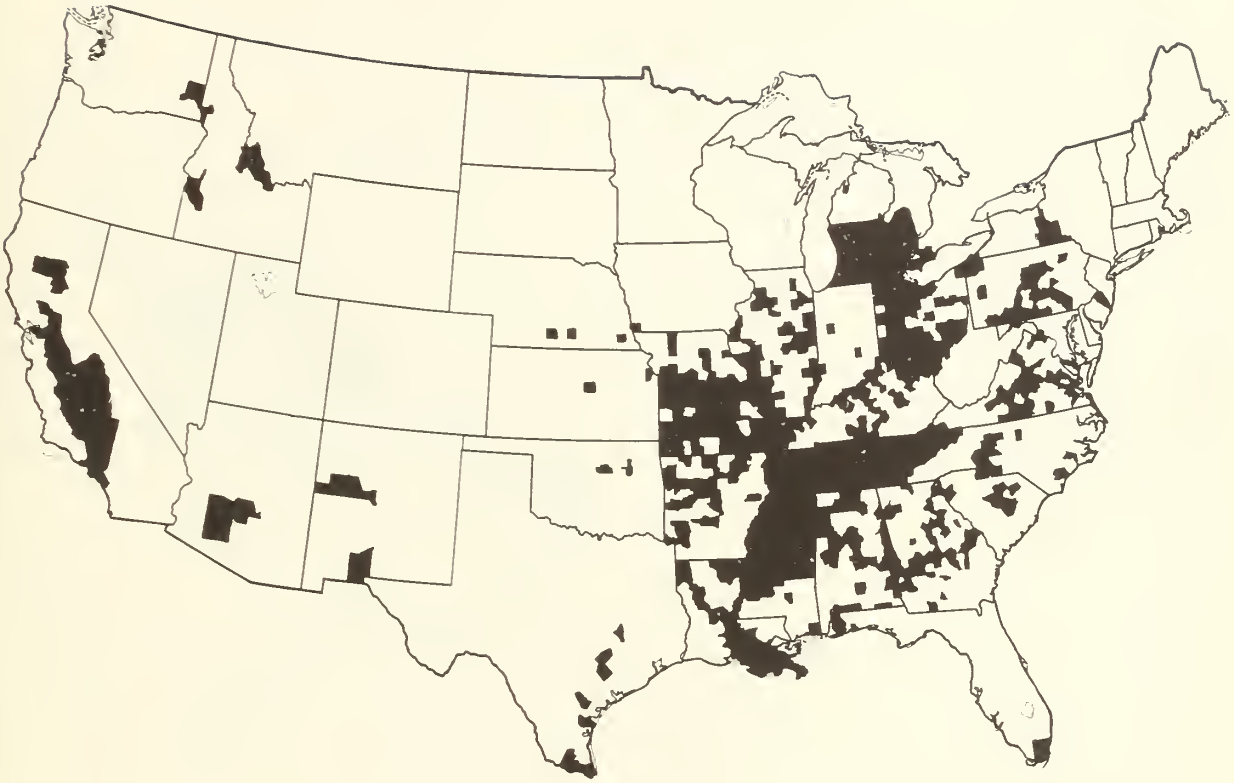

FIGURE 3.--Counties where virus infections are known to have occurred in corn through 1965. This distribution is a composite of all viruses; CSV, SCMV, MDMV, 3AV, and WSMV. The locations were derived from cooperators' reports of surveys based on observation of symptoms or on virus recoveries, literature citations, and personal communications. The ranges of the viruses overlap and in certain cases more than one virus may occur in a county.

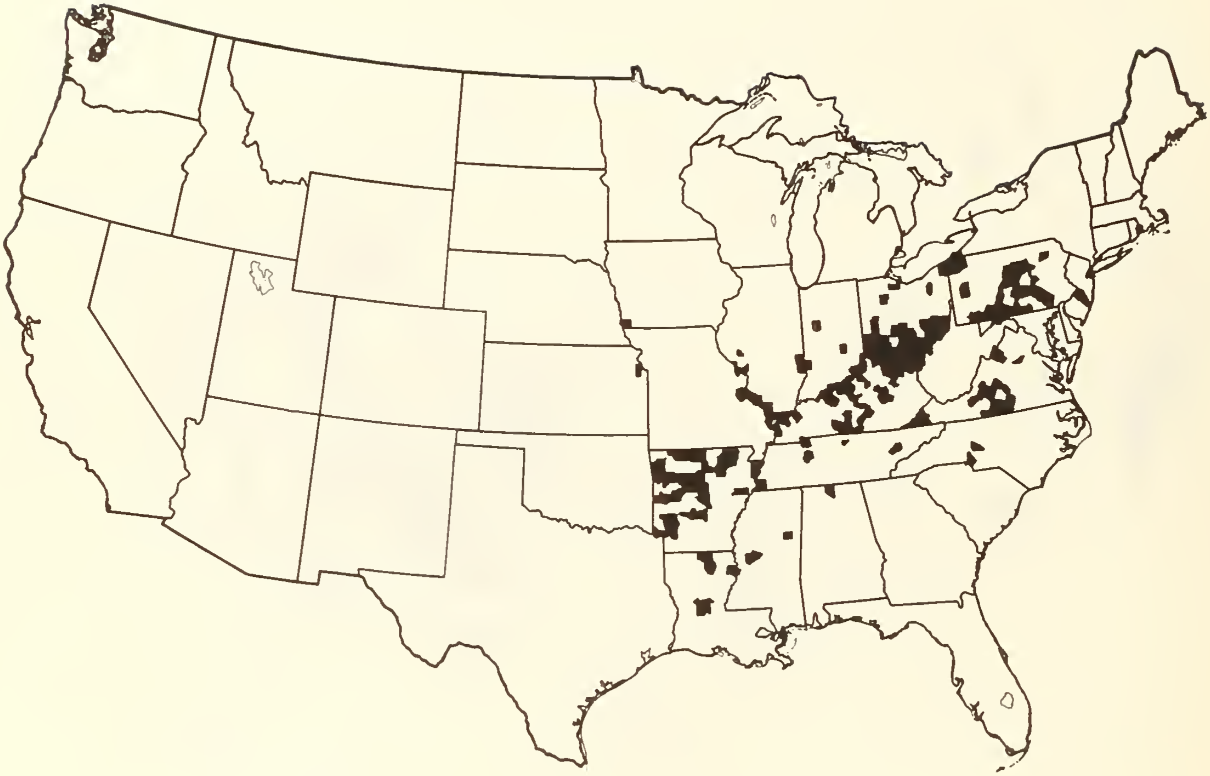

FIGURE 4.--Distribution of known MDMV infection through 1965, as determined by recovery of the virus from field-infected plants. This figure was derived from cooperators' reports from 1963 to 1965, inclusive. See the Texas sectional report for MDMV distribution in Texas in 1966. See the California sectional report for distribution of the Jg strain of SCMV.

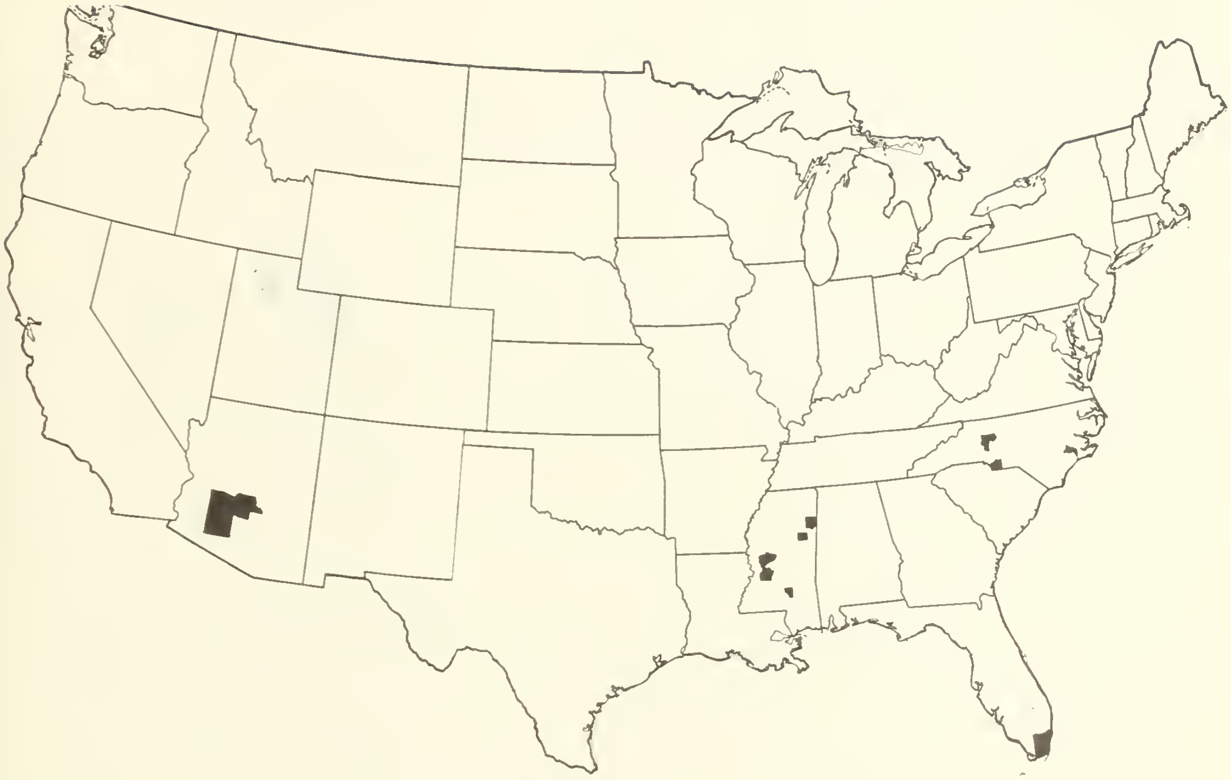

FIGURE 5.--Distribution of known CSV infection through 1965, as determined by recovery of the virus from field-infected plants. This figure was derived principally from reports of investigations conducted at the Boyce Thompson Institute. Distribution of CSV in Texas is not shown, since there is ambiguity on the origin of the field material used by Kunkel in the first transmission of this virus. See the sectional report of Louisiana for additional information.

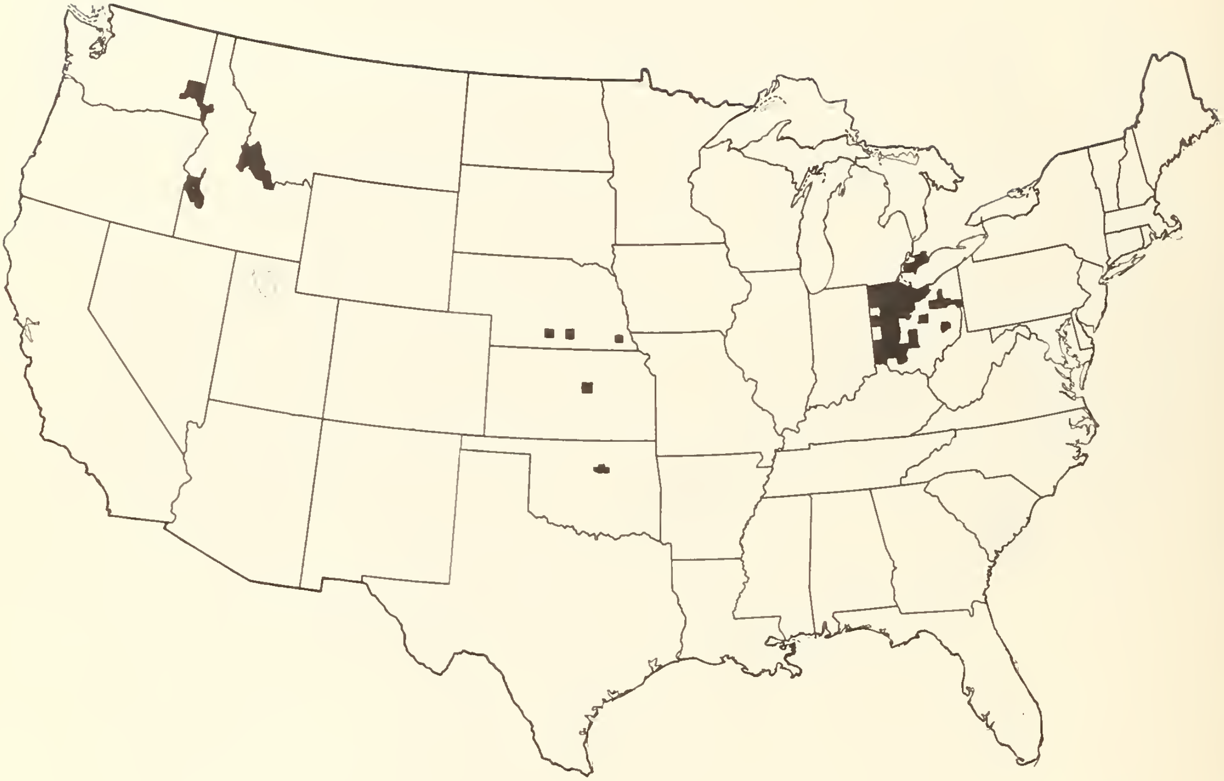

FIGURE 6.--Combined ranges of WSMV and 3AV, as determined by recovery of the viruses from naturally infected corn. WSMV occurs in the Pacific Northwest, Central States, and Ontario Peninsula. 3AV has only been reported from Ohio through 1965. This figure was derived from cooperators' reports and the literature.

GENERAL DISCUSSION OF SOME CORN VIRUSES IN THE UNITED STATES AND CANADA[1]

Warren N. Stoner[2]

Corn virus diseases have become increasingly important in North America north of Mexico since 1962. Economic losses from virus infections in corn have recurred each year since then in some parts of a general area bounded by latitude 96 W., longitude 43 N., the Atlantic ocean on the east, and the Gulf of Mexico on the south.

In the initial phase of the investigations of the corn virus problem (1963), it was believed corn stunt virus (CSV) was of main concern. As the work progressed it became clear that other viruses were involved.

Maize Dwarf Mosaic.--One of the viruses was recognized as a separate entity and named "maize dwarf mosaic virus" (MDMV) in 1964. This virus was characterized by several investigators. It is a nonpersistent virus with a fairly wide gramineous host range, including johnsongrass which in many areas is believed to be a major perennial overwintering reservoir host. The virus is transmitted by several species of aphids, particularly the corn leaf aphid, *Rhopalosiphum maidis* (Fitch). It has been experimentally demonstrated that the acquisition and inoculation thresholds of MDMV for some of the aphid vectors are very short; i.e., minutes. The latent period of MDMV in some vectors is also short, again a matter of minutes, so transmissions of the virus can be effectuated experimentally in a short time. These biological characteristics and the physical-chemical properties of the virus are very similar to those exhibited by sugarcane mosaic virus (SCMV) and its strains. Serological comparisons of MDMV and sugarcane mosaic virus (SCMV) have been made. These strongly indicate that MDMV is related to SCMV or may be an hitherto undescribed strain of SCMV. Some investigators now consider MDMV as a strain of SCMV and separate MDMV from other strains of SCMV on the basis of its infectivity in johnsongrass. Maize dwarf mosaic (MDM) can and does occur in the field very soon after planting, within 30 days after seedling emergence. This early appearance of symptoms of MDM allows a field separation from corn stunt but does *not* distinguish MDMV from other known nonpersistent viruses that infect corn. The known distribution of MDMV is given in figure 4 of section "General Summary of Corn Virus Distribution."

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[1] This general discussion was developed from conversations with many cooperators, field surveys made in several States, greenhouse investigations and field observations made particularly in Mississippi and Ohio, personal correspondence, and a perusal of the literature. The reader is referred to individual sections of this report for specific information of a given State or Province.

[2] Entomologist, Entomology Research Division, ARS, U.S. Department of Agriculture, Northern Grain Insects Research Laboratory, Brookings, S. Dak. 57006.

Corn Stunt.--Corn stunt disease has been recognized as being caused by a persistent virus and occurring in the southwestern border States from Texas to the Pacific coast since 1946.

In the period of 1963 to 1965, corn stunt virus (CSV) was recovered from field samples from Florida, Mississippi, and North Carolina, extending the range of the virus. Until 1966, CSV was only known to be transmitted by two species of leafhoppers, *Dalbulus elimatus* (Ball) and *Dalbulus maidis* (DeLong and Wolcott). *D. elimatus* has only been recorded occurring in the United States along the border in New Mexico. *D. maidis*, until 1964, was only reported north of Mexico -- from Arizona, California, Florida, North Carolina, and Texas. Since then, *D. maidis* has also been collected in Arkansas, Georgia, Louisiana, and Mississippi. Recurrent appearance of corn stunt in the latter two States early in the season, before the *Dalbulus* vectors are seen, and apparent occurrence of the disease in areas where the *Dalbulus* vectors are not known, led to a search for unknown indigenous vectors. The black-faced leafhopper, *Graminella nigrifrons* (Forbes), was shown in 1966 to be capable of transmitting CSV experimentally. This leafhopper is the third known vector of CSV and is ubiquitous in the area where corn viruses have been reported. *G. nigrifrons* is, therefore, potentially a vector of CSV throughout this area. Many plant species have been tested for susceptibility to CSV, but only two -- corn (*Zea mays* (L.)) and teosinte (*Euchlaena mexicana* Schrad.) -- have proved to be hosts of the virus. Both are considered annual plants. Therefore, the question of where carryover of CSV from season to season occurs is not resolved. If the virus is not carried over in an indigenous or migrating vector, the appearance of corn stunt early in the season over a wide area in its range indicates that there is probably an indigenous perennial host, or hosts, in the area. It is also likely that such virus reservoir host, or hosts, may also be a suitable breeding host, or hosts, of the insect vector transmitting CSV in the field. Vector investigations and host range studies of the CSV portion of the corn virus problem have been initiated and are continuing in several locations. Counties where CSV has been recovered from field plants showing symptoms of the disease are shown in figure 5 of the section "General Summary of Corn Virus Distribution."

Sugarcane Mosaic.--Sugarcane mosaic virus (SCMV) has been known to infect corn in the United States for about 50 years. Its affect on corn is not completely known, but it is thought not to be too severe. Critical studies are needed of the affect of SCMV and its strains on corn varieties now being grown. Sugarcane mosaic virus is, like MDMV, a nonpersistent virus with several aphid vectors, including the corn leaf aphid. It has a fairly wide gramineous host range that does *not* include johnsongrass. Infections of SCMV in corn can be widespread in areas where sugarcane is grown, and it may be particularly troublesome where the so-called noble, soft, chewing, or big barrelled sugarcane varieties are being produced.

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The general area of occurrence of SCMV runs from the interior valleys of California south then east through the Southern States, particularly in those on the coast of the Gulf of Mexico. The counties where SCMV was recovered from field-infected plants in 1965 are shown in the figures of the sections in this report from California and Louisiana. During the last 3 years (1963-1965) intensive investigations of corn virus problems in California have indicated that SCMV or MDMV may have been taken for CSV by Kunkel in his original publication. Investigations in Louisiana now show that both CSV and SCMV occur there. The reader is referred to the California and Louisiana sections of this report for specific information on SCMV in corn in 1965.

Wheat Streak Mosaic, and Pericarp Red Stripe.--Wheat streak mosaic (WSM) is caused by infections of the wheat streak mosaic virus (WSMV). Like MDMV and SCMV, it is a mechanically transmissible nonpersistent virus, but, rather than aphids, it has as its vector an Eriophyid, the wheat curl mite, *Aceria tulipae* (Kiefer). The host range of WSMV includes oats, barley, and several weed and range grasses. This virus has been studied primarily as a pathogen of wheat, since it has caused serious losses in that crop. It has, however, also been reported causing losses in corn in widely dispersed areas. The virus of corn variously called sweet corn mosaic virus and maize virus 2 may be WSMV or a strain of it. In systemic invasions of corn by WSMV a mosaic pattern develops as intermittent or continuous interveinal streaks. A general chlorosis and stunting of the plant may follow in some varieties. Ears on infected plants may be subnormal in size and kernel set may be irregular. No one working with WSMV in corn, however, has ever reported any color aberration in the kernels set on infected cobs.

A virus isolated from field-infected corn in Ohio in 1964 possesses characteristics similar to those of WSMV. This virus has been tentatively called 3A virus. It is nonpersistent and mechanically transmissible to corn, wheat, and several other gramineous hosts. No vector of 3A virus is known, but a search is now in progress to try to find a vector, or vectors, of the virus. In general the symptoms of 3A virus in corn are similar to those caused by infections of WSMV. In corn infected with 3A virus, however, a red striping of the pericarp of mature kernels is frequently seen. It is known that other factors can cause red striping in corn kernels and that the red stripe of kernels does not always occur in plants infected with 3A virus. Nevertheless, 3A virus has been isolated repeatedly from mature, but not dried, kernels showing the red stripe symptom. Whether or not the red stripe symptom of the kernel pericarp is due to or related to infections of 3A virus has not been clearly established, but investigations are in progress to clarify this point. The 3A virus has been isolated from naturally infected wheat in several locations and serially transmitted from corn back to wheat. In wheat the symptoms produced by 3A virus infections are almost identical with those induced by WSMV infections. The red stripe symptom in corn kernels has been observed primarily in northern Ohio, northeastern Indiana, southern Michigan, and on the tip of the Ontario Peninsula in Canada. Figure 6 of the section "General Summary of Corn Virus Distribution" shows the counties where both WSMV and 3A virus have been recovered from corn naturally infected with these viruses.

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